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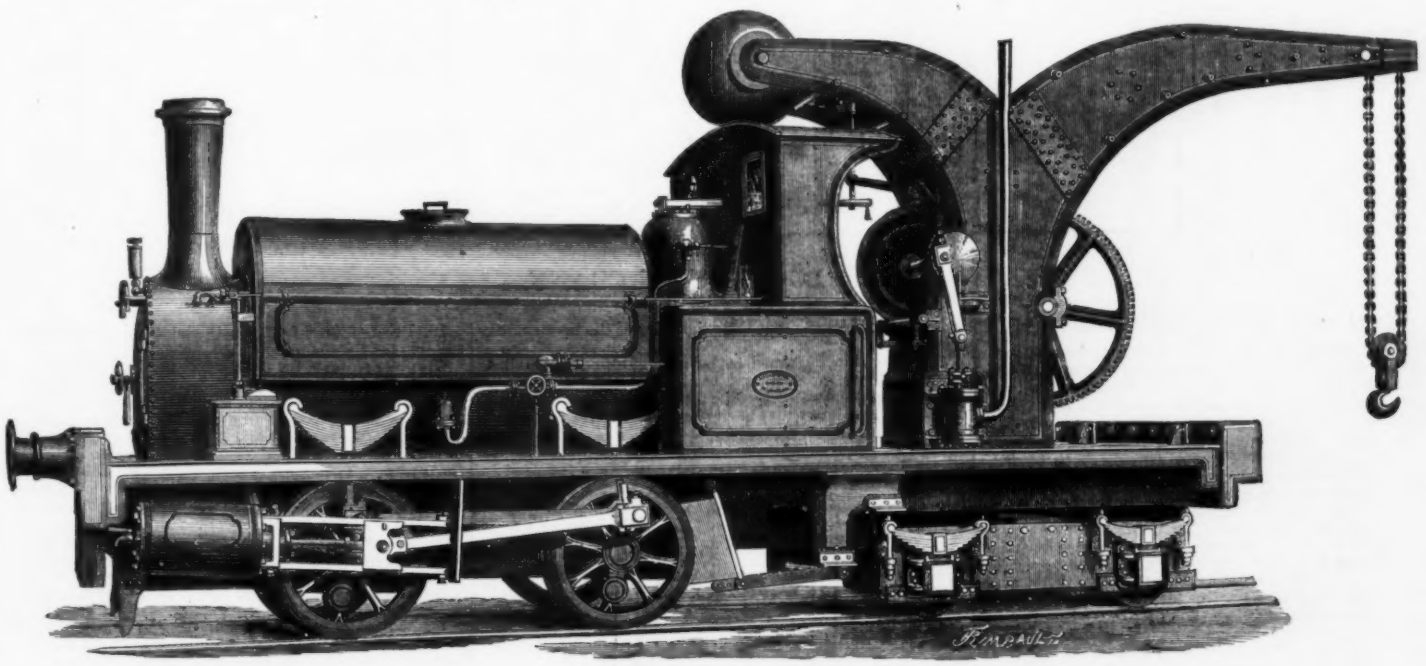
LOCOMOTIVE CRANE.

The locomotive crane, of which we publish a perspective and detailed drawings, was constructed by Messrs. Black, Hawthorn and Company, of Newcastle-on-Tyne, and has been at work for about eight months at the Newburn Steel Works, belonging to Messrs. John Spencer and Sons, Newcastle-on-Tyne. These works are connected with the North-Eastern Railway by a junction line, and the engine is employed for hauling trucks between the works and the line, and for general shunting purposes. The arrangement of the crane is shown in the perspective view. It is adapted for lifting four tons, and is worked by two vertical steam cylinders, 6½ in. stroke and 8 in. in diameter. The steam for working the crane is led from the steam boiler by the pipe shown in dotted lines, leading from the steam dome to a point underneath the centre of the crane post; it then passes up through the centre of the post, and enters a bent pipe, one end of which works in a stuffing-box. By this pipe it is brought down to the cylinders. The crane post is of wrought iron, bolted to a cast-iron bed-plate, attached to engine frame. The jib is a plate and angle iron structure, and is balanced by an arm similarly constructed, and carrying at the end a heavy counterbalance weight, as shown. The arrangement of transverse bearing of the jib, and the position of pulleys is shown in Figs. 3 and 4, as well as the arrangement of driving pinion and spur on the chain drum. The locomotive with crane weighs 24 tons in working order, and will draw a load of 31 tons up a gradient of 1 in 33, the ruling incline of the line over which it works, or a load of 220 tons on the level, besides itself. The cylinders are 10 in. in diameter and 17 in. stroke. They drive four coupled cast-steel wheels with steel tyres. The firebox is of copper, and the tubes brass. The working pressure is 150 lb. per square inch. The end of the framing carrying the crane is supported on a four-wheel truck, of which the crane post forms the centre around which it turns. A lateral movement of 12 in. is also allowed, to enable the engine to run freely round the 75 ft. curves upon the line. The various levers for working the crane are placed so as to be of easy access from the foot-plate, and are controlled by the same man who drives the locomotive.—*Engineering.*



NEW LOCOMOTIVE CRANE.

A NEW PASSENGER COACH.

A VALUED correspondent sends us the following detailed description of a new first-class passenger coach just completed at the shops of the Jeffersonville, Madison and Indianapolis Railroad, at Jeffersonville, Ind., and built to replace one of the same class destroyed by fire.

Like all the standard coaches of this road, the body is 56 feet long exclusive of the platforms, 10 feet wide outside of panels, and 7 ft. 6 in. high from floor to center of dome roof. The floor framing is of yellow pine, excepting the end-sills, which are oak. The side and end-sills are 5x8½, and the two centre and two intermediates 4x7½. The side-sills are tenoned into the end-sills, and not the reverse as is often the case. The body bolsters are oak 5x13, with a plate of ⅜x4½ iron on each edge, with bolts running through. There are four 1-in. truss-rods in each bolster. The corner posts are oak 1½x3, and 6 ft. 10 in. between sills and plates. The outside panneling is ¼ inch poplar. There are 18 windows on each side, with oval tops and 36 in. from center to center. Glass 20x28. End windows being practically useless in coaches that have a stove and saloon in each end, have been omitted. The raised roof extends the entire length of the body, and terminates in an easy o.g. curve to the car-line of the platform roof. This is somewhat of an innovation, but has been found less expensive, as well as giving a well proportioned outside appearance and a better inside finish. There are no curves, points, or oval work on outside to catch water and induce incipient rot, the outside ornamentation being left almost entirely to the painters. The body-color is brown, the striping and scroll-work yellow, except on the door posts where it is gold leaf. On the corner and door posts are the company's monogram "J. M. & J." in tasteful design. The letter board is inscribed with the terminal points of the road, "Louisville and Indianapolis." A ⅛ sheet-iron hood extends around the platform roofs. The platforms are the ordinary style—not Miller—a 3-link cast iron draw-bar is placed as close as possible to the line of resistance without cutting the platform sill, its centre being 38 in. above the rail.

Standard 6-wheel trucks are used; wheel base 10 ft., 8x10 four-coil Hebbard springs on equalizers, and 40 in. couplet French eliptics under bolsters. The axles are 6 ft. 9 in. long with 3¾x7 journals. A plate or lug is cast in the front end of oil-box, which when new, gives ⅜ end-play on the journal; the brasses have ¼ end-play. Some of these brasses have shown scarcely any wear after six months' running, which speaks well for the plate in end of the oil-box. A spring lid for oil-boxes, designed by Mr. Reuben Wells, the master mechanic of the road, has proven very successful; 500 of them are now in use on the road, and not one of them has been lost or broken. The Westinghouse brake in its original form is used. There are 28 Hitchcock ventilators in the deck, and the same number of Creamers in sides. There are also drop-sashes in doors.

The interior finish is in oak and walnut, a combination which presents a very pleasing appearance, but to enter into details would require too much space. One peculiar feature of the inside arrangement of this car consists of a smoking room, 12 feet in length, placed in one end, to accommodate smokers when travel is not sufficient to warrant the running of a smoking car proper. The heating is by two of Spear's hot air wood stoves; the lighting, by centre and bracket side lamps, with mineral sperm oil. The seat frames are oak, upholstered with crimson and green plush, and provided with Cobb's springs. The head-lining was designed and executed in the company's shops by Mr. H. Thomas, the foreman painter, and is the finest on the road. The weight of the car complete is 50,125 pounds, which is about 4,500 less than other cars upon the road of same size and capacity. This road is credited with running the most comfortable passenger cars of any of the roads that centre at Indianapolis, a fact that is in great measure due to the marked and well known ability of Mr. Wells as a railway mechanic. His assistant in the car department is Mr. J. D. McIlwain, who has filled the position he now occupies for upwards of a year.—*National Car Builder.*

LIGHT FREIGHT CARS.

WE have heretofore called attention to the fact that quite a number of specimen light freight cars have been built from time to time within the past ten years, for the purpose of determining whether the weight of ordinary box cars can not be materialy reduced without reducing their carrying capacity or their ability to resist the usual strains of concussion. Some of these cars have been placed upon the track and worn out in ordinary service, and according to the testimony of their builders, they have made a record entirely satisfactory. Many years ago a number of them were built by the Pennsylvania Railroad Company. One of these, which was considered a model in its way, was 28 feet long and 8ft. 6 in. wide, had very light trucks, and weighed altogether only 14,300 pounds. Its carrying capacity, we believe, was estimated at ten tons. It ran eight years, and required no more than ordinary repairing. Another was built in 1872, under the direction of Mr. C. A. Smith, who was at that time in charge of the Jersey City shops of the Erie Railway. This car has now been running four years on this road, and to all appearance is nearly as good as new. It is of course adapted to a six foot gauge, and the trucks are consequently heavier than would be necessary for standard gauge. The total weight of the car is 17,700 lbs., which is 3,300 less than the standard weight of the same class of cars used on the road. The body is 29 ft. long and 8 ft. 8 in. wide, and weighs 8,150 lbs. Wheels, 540 lbs. each; axles, 400 lbs.; journals, 3¼x6; wheel base, 6 ft. 7 in. The ordinary load carried is 15 tons, but its maximum carrying capacity may safely be put at 20 tons. This it will be seen is a very light car for the load it carries, and if the weight of wheels and axles and width or trucks were reduced to suit an ordinary gauge, the proportions of dead and paying weight would be still more favorable. In regard to the manner in which a reduction of 3,300 pounds has been made without impairing the strength of the structure, it is obvious that a careful selection of materials and their proper distribution, have been the important points. The framing throughout is of selected oak, and the iron work of the best refined iron. The size of the floor timbers has been considerably reduced, except the center sills, which have to resist the direct buffing strain. The roof, sides, and ends are as light as the quality of material and the comparatively small strain upon the parts seem to justify. In a word, the aim of the builder has been to put strength where it is most needed, and dispense with all superfluous bulk and weight.

Now why are not more cars built of this description, or rather upon this plan, and the burden of dead weight reduced as indicated in the above figures? Why are these specimen cars permitted to wear themselves out without being duplicated, and without attracting the attention they deserve as models for imitation? If dead weight is really a tax upon motive power and earnings, why not get rid of it as far as practicable in the construction of freight cars? A reform in this direction does not for some reason meet with much encouragement from managers. An exceptionally light car that carries the same load as a heavy one, with as long a life and as light repairs, is looked upon as a kind of curiosity, a thing in advance of the age which must bide its time and come into fashion one of these days. In spite of the manifest advantages of lighter rolling-stock, there seems to be a powerful under-current of prejudice against it. It is assumed that a freight car of ordinary dimensions can not be made lighter, and carry the same load, without risk of being broken and crushed when put into trains with heavier ones. That this is a mere assumption, however, is shown by the record of the specimen cars to which we have referred, and especially by the one built by Mr. Smith, which

speaks for itself. It has been running for years in trains made up of cars of the usual weight and construction, and has suffered no injury thereby, which shows that it is not deficient in strength or capacity of endurance. It is evident that if any advantages are ever to be realized from the use of lighter cars, such cars must be built in the future on a more extensive scale than they have been in the past, and this can only be done with the aid and encouragement of railroad managers, and a due appreciation on their part of the efforts of car builders in this direction.—*National Car Builder.*

the requisite pressure is up and the engine ready for vigorous action.

In some cities the supply of hydrants is limited, and it sometimes becomes expedient to group together several of the smaller engines when but one can conveniently supply itself from the available hydrant. In this case it is found advantageous to use the larger class engine to supply the smaller ones that act directly on the fire.

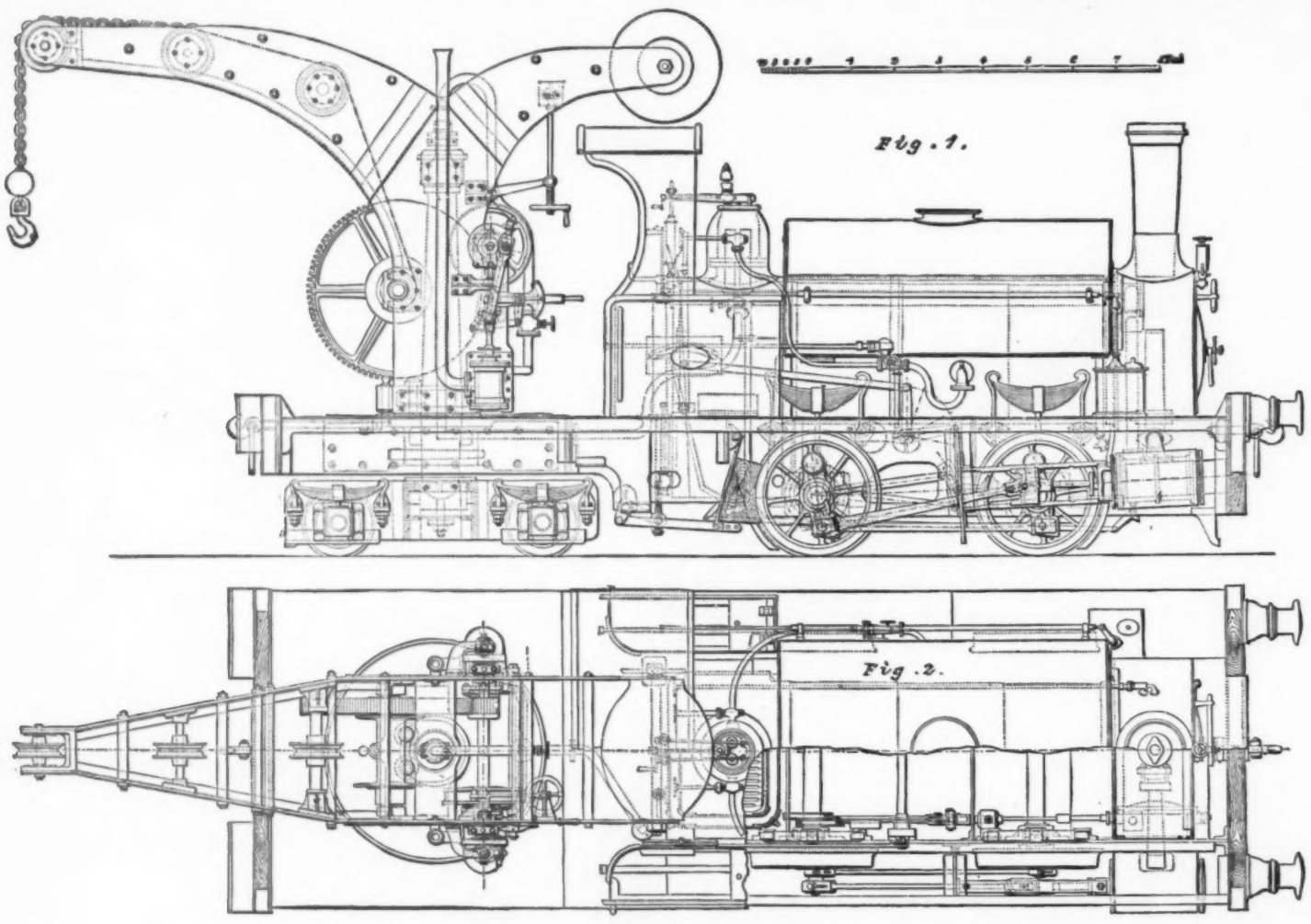
Upon reaching the scene of the disaster, the respective forces come under the control of the higher officers who distribute the engines, hose carts, hooks and ladders, fire-

instantly announced in every engine-house and police station. Hence it rarely happens that several steamers are not at position in three or five minutes after the alarm of the discovery of the fire has been sent.—*Engineering.*

PRIZES FOR INVENTORS.

(Continued from page 837.)

WE continue below the details of inventions for which prizes are offered by the French Society for the Encouragement of the National Industry:



NEW LOCOMOTIVE CRANE.

THE AMERICAN FIRE DEPARTMENT.

THE organizations for suppressing conflagrations in most of the cities of the United States is so complete, and the details of the work connected with it are carried out with so much personal energy and zeal, that Americans very justly pride themselves upon a system which the inflammable character of a large number of the buildings in all their cities has rendered an absolute necessity.

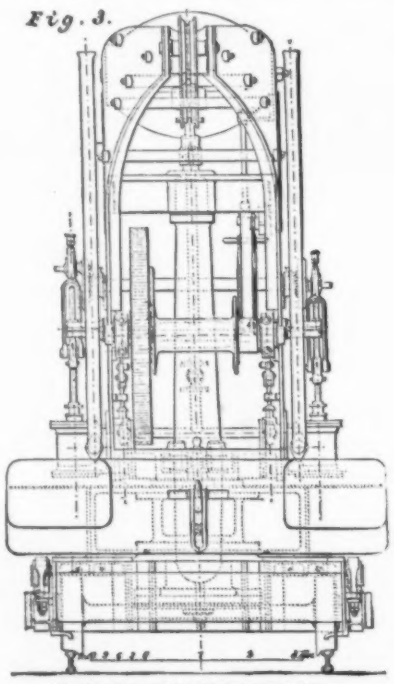
In nearly all the principal towns and cities of the United States, such organizations exist. While agreeing in general features, they may differ in detail and in discipline according to the local wants, the ideas and inventive faculties of individual chiefs and organizers. As it may afford our readers some interest to know a little more about these admirable organizations, we shall briefly describe the general and common features of the several systems employed. We may, for the sake of description, suppose the city to contain a population of 100,000, and to cover an area of ten square miles. Such a city would employ six steam engines (one first-class, and five of the third or lightest class), four hook and ladder companies, and three independent hose companies. The "steamers" are almost invariably drawn by horses specially chosen and trained for this work. A full company of firemen consists of nine men, exclusively employed by the municipality for this purpose. They live in the engine-houses, which are comfortably fitted up with sleeping apartments, bath-rooms, parlor, library, &c. The entire force is under military organization; the officers are called respectively chief, assistant-chief, captain, and lieutenant. Of these men a certain number must always be on the watch; the dress and equipment of the others is such that whatever may be their state or occupation when the alarm is received, they may be ready for action in two minutes.

The engine is kept in a room with wide folding-doors, and the water in the boiler is kept constantly warm by means of a small stationary boiler fitted up in the cellar of the building. The fuel required to start the fire is obtained from the furnace of the local boiler. Besides these preparations, a bottle of turpentine and a box of matches are placed on the platform of the engine under the control of one of the firemen.

An alarm being sounded, the harnessed horses are automatically released from their stalls, and spontaneously spring to the front of the engine, where two men on either side are ready to receive them and attach their traces. Meanwhile the other men immediately place themselves as follows: one on the driving-box, one at the steam-connecting pipe, one on the furnace platform, and one at the folding-doors. The several actions of attaching the horses, gathering up the reins, pouring the turpentine on to the prepared fuel and lighting it are simultaneous and instant; and in thirty seconds after the first tap of the signal is received, the engine may be out of the house and dashing at full gallop towards the scene of the conflagration, while in five minutes more

escapes, etc., according as the exigencies of the moment may demand.

The several manœuvres to be accomplished in handling these machines are few and easily acquired. Every man knows his place and his specific duties. He is so thoroughly drilled in these latter that he performs them with marvellous precision and almost incredible rapidity.



NEW LOCOMOTIVE CRANE.

The efficiency of the American Fire Department depends not upon its numerical force, but upon its perfect discipline and promptness of action. But these excellent qualities would be of little effective value were they not supplemented by good apparatus and elaborate system of fire alarm telegraphs, by means of which the first appearance of any fire is

10. Prize of $600 for the artificial production of graphite suitable for the manufacture of pencils.

Graphite suitable for lead pencil making, without requiring previous preparation, has become very rare. Ancient mines are nearly exhausted, and the present source of supply is the rich deposit discovered in Siberia. Large as the Siberia mines are, however, they cannot continue yielding indefinitely, and while their product is failing, the demand for pencils is constantly augmenting. Would it not be possible to obtain graphite artificially, in masses large enough to answer industrial requirements? Could not the material be obtained without having recourse to the washing and agglomerating processes, the product of which is not good? The well known occurrence of graphite in crystalline rocks and especially in crystalline limestone, allows of anticipating the solution of the problem. It is well known besides, that graphite constitutes the most stable state of carbon; that it is formed under various circumstances, and that in particular it is obtained by heating the diamond in the electric arc, and that it becomes abundantly separated from gray pig iron at the moment of solidification. It is therefore necessary to study and to formulate the conditions of production of a body the artificial formation of which is already understood, and to discover a practical process for utilizing it on a large scale. Prize to be awarded in 1878.

11. Prize of $600 for the artificial preparation of the black diamond.

Chemistry has proved that carbon, graphite or plumbago and the diamond are identical substances. The conversion of the diamond into plumbago is easily accomplished, and the inverse operation, that is to say the conversion of graphite into diamond is certainly possible. But it does not follow that the diamond shall be in crystallized form or a gem. The industrial need lies not in the jewel but in hard amorphous masses of carbon, such as constitute the bort or black diamond, now the best known agent for cutting and drilling the hardest substances. Not much is known about the black diamond, which with the jewel is found in alluvial sands produced by the disaggregation of rocks more or less ancient which are themselves drift. We have no certain knowledge regarding the primitive gangue of the diamond, and we know of no difference in the bed which admits of determining a corresponding difference between the modes of formation of the crystalline and compact varieties. It is known, however, that varieties of anthracite exist of exceeding hardness. Hence, it may be considered that the causes which produce common anthracite being modified, may be able to give it a hardness approaching that of the bort. The society attaches so great an importance to the fabrication of the black diamond that it agrees to recompense liberally any one, who by a study of the diamond beds, will furnish a point of departure more certain than now exists for experimental researches into the production of the precious substance. The prize will be decreed in 1878.

12. Prize of $800 for the discovery of processes capable of

furnishing by any chemical transformations, useful organic substances, such as quinine, cane sugar, etc.

Organic chemistry possesses theories and practical methods by means of which the production of a large number of substances by transformation may be predicted. Urea, oil of bitter almonds, alcohol, fruit essences, formic acid, etc., have all been produced by certain processes starting from substances, the constitution of which seemed widely different from that of the resulting bodies. There is no limit to these new arrangements of atoms. In the eyes of theory there is no difference between the production of urea and that of indigo or quinine, between that of formic acid and that of cane sugar. Practically, the discovery of quinine produced artificially would be of enormous value and would ensure the discoverer undying fame and great wealth. The society offers the above prize, not for the discovery of processes commercially valuable, but for the simple finding of any method for the artificial formation of a useful substance of the above class. Competition will be open until the close of 1880, when the prize, if it be merited, will be awarded.

13. Prize of $800 for the artificial preparation of fatty acids and waxy matters.

As it is now possible to convert organic substances into organic substances by regular processes, the discovery of a process is required, capable of producing artificially stearic acid, paraffine or any of the waxy matters employed in candle making. The society will award subsidiary prizes for any new process for the preparation of fatty acids, yielding in solid acids the best quality at the cheapest price, or for producing oleic acid or glycerine in the least odorous, whitest and least costly form. Prize to be awarded in 1882.

14. Prize of $1,200 for a theory of steel founded on certain experiments and having as its result a means of improving steel fabrication.

The constitution of steel is not known. The delicate operations practiced for the production of that necessary metal are founded on empiricism; but even if the nature of steel continues to remain unknown, it may become possible to direct its preparation by more certain rules, and so to improve its quality. The question is, then, how can we convert common steel into a metal of superior quality without knowing exactly wherein the difference between the two, lies? The Society thinks that the only way of reaching a definite solution of the problem, is to found a theory on a long series of experiments varied and controlled in the actual practice of steel making. Efforts in this direction will be encouraged by medals and annual recompenses. The above prize will be decreed in 1879.

15. Prize of $400 for the disinfection or purification residues of gas works.

The purifying materials generally used consist in a mixture of sesquioxide of iron (hydrated,) sulphate of lime and lime in excess. The residues are extracted from the purifying vessels in the state of protoxide and sulphide of iron mixed with sulphur, carbonate of lime, sulphide of calcium impregnated with carbonate, sulphocyanhydrate, and acetate of ammonia, with divers hydro-carbons, carbolic acid, sulphurous essences, and in a word, all the volatile coal tar products. It is possible to revivify or rather re-oxidize these ferruginous residues, so as to render them serviceable for a number of times, by exposing them under open sheds, and agitating them frequently so as to ensure abundant contact with the atmosphere. During the emptying of the purifying vessels, and the exposure of the residues, a large amount of disagreeable vapors are engendered, which are wafted by air currents over great distances, and hence become a nuisance to the population in the vicinity of the works. It is known that by effecting the re-oxidization in the purifying vessels themselves without opening them, by directing the gaseous products into a furnace, the sulphurous vapors are transformed into water, carbonic and sulphurous acids, and may then be discharged into the atmosphere without causing inconvenience. But in this process it is difficult to avoid the alteration of the screens and the over heating of the mass which is re-oxidized. Perhaps it may be well to use grates of hollow bricks, and to diminish the thickness of the layers of residue. Whatever may be, however the means employed by competitors, if they are efficacious, economical, if in a word they have realized in a large gas works the means of re-oxidizing purifying mixtures, while preventing disengagement of infected gases, they will be entitled to the recompense offered. The prize will be decreed in 1881.

16. Prizes of $300, $200 and $100, relating to the use of boric acid and borax in the ceramic arts

Something is wanted to replace boric acid and borax in the glazing of fine faïence without injury to the quality of the product. Phosphates and certain silicates, slightly plumbiferous, roasting at high temperatures, the resulting compounds of mixtures of fluorspath, quartz, and clay, kaolin or sulphate of lime, which M. Berthier has indicated, some micas and lepidoliths which M. Regnault has analyzed, would probably form suitable glazings of sufficient hardness and not dangerous in use. Any other mode tending to regulate the price of borax, any discovery creating on French territory a regular exploitation of boric acid which will satisfy the exigencies of the ceramic arts will be acceptable. It is known, for example, that Beudant has found in the water of Hungarian lakes notable quantities of boric acid, which on evaporation, was deposited under form of native borax. The prizes which will be awarded in 1882 will be given as follows: $300 for a composition which may be substituted for boric acid or borax in the glazing of pottery without altering the value or lowering the price of the same. $200 to the discoverer of exploitable beds of boric acid in France or in French possessions. A medal worth $100 will be given to whoever shall introduce into France for treatment there, matters other than tinkal or crude acid of Tuscany, containing boric acid sufficient for regular exploitation.

17. Prize of $200 for the extraction in France of the iodine contained in the nitrates of soda found in South America, and from borates and mineral phosphates.

South America nitrate of soda contains iodine in exploitable quantities under two different forms, iodides and iodates. The latter are the most abundant. The iodine is extracted in South America from the mother liquor from the refining of nitrate of soda; but the treatment is difficult, and as a rule more than 40 per cent. of the iodine in the liquor is obtained. If the crude matter could be transported to Europe and there refined, a much greater percentage might be obtained. There are also certain natural borates and phosphates which are a valuable, but now neglected source of iodine. They are largely used industrially, owing to their constant employment in the manufacture of agricultural superphosphates. The prize will be awarded in 1877.

18. Prize of $600 for an industrial process for the fabrication of cast steel rails, using only common ores containing like oolithic ores, from .5 to 1.5 per cent. phosphoric acid.

Cast steel cannot be made by the Bessemer or Siemens-Martin process without the aid of ores of a superior quality, which are manganiferous and which contain no phosphorus. The cost of the ores is rapidly increasing, while the yield of them is growing smaller, so that it is necessary to find means for making use of ordinary ores in the manufactures. Pure oxidized irons should be reserved for the production of choice steel for tyres, axles, springs, tools, etc. Rail steel of which the consumption is great, should be made from common ores. Can cast metals and ordinary ores, more or less phosphorous, be purified by a simple and not costly process, and transformed into cast steel by refining? Prize to be awarded in 1877.

19. Prize of $200 for the establishment in France of works for the complete treatment of nickel ores and the preparation of the pure metal.

There is an abundance of nickel ore in France, which is now sent out of the country for the extraction and purification of the metal. The above prize will be given in 1877 to whoever will establish works as stated.

20. Prize of $500 for the continuous fabrication of a cast steel or iron having properties of especial utility, by the incorporation of a foreign metal.

Faraday's researches have shown that several metals, such as platinum, palladium, chromium, etc., modify the properties of steel in a notable manner in cases where these metals are not allied to iron but in small proportions. More recently it has been found that the addition of tungsten hardens steel, so also manganese has in some cases been found a beneficial ingredient. What is required is to determine the special influence of foreign metals on the properties of iron and steel. Prize to be awarded in 1880.

21. Prize of $400 and of $200 for the industrial fabrication in France of fuming Nordhausen sulphuric acid.

This acid is indispensable in the production of such bodies as artificial alizarine, but at present is wholly made in Germany. The larger prize will be awarded to whoever produces the acid in France by a cheaper process than is now known, and the smaller one to whoever establishes the regular manufacture of the acid on French territory. Prize to be decreed in 1879.

The prizes for inventions in the economic arts, agriculture, and fine arts, the details of which conclude the series, will be announced in our next issue.

ARTIFICIAL INCUBATION.

A CORRESPONDENT of the *Country Gentleman* says:

"There having been many inquiries, within the last few years, for the most approved methods of hatching and rearing chickens, without the assistance of the hen, and without too great expense, I send the enclosed sketches of hatching-box and artificial mother in use in France, and invented by M. Carbonnier. The construction and operation of both are so simple that I believe almost any one of ordinary ingenuity can make and use them successfully. Fig. 1 represents the incubator, with the drawer containing the eggs, partly drawn out. Fig. 2 shows a section of the same. The upper part of

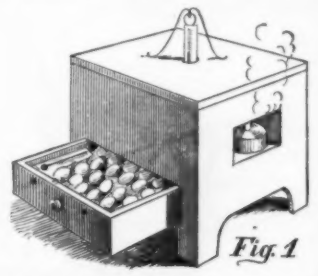


Fig. 1

the box contains a zinc reservoir, with a space left, as shown in the drawing, for the introduction of the lamp, and a small tube passing through the top of the box, which serves for filling it with water, and also for holding a thermometer, which, plunged into the water below, indicates the temperature. Thermometer tubes may be obtained, and held in position continually by inserting through a perforated cork of the proper size; the temperature of the water may then be seen at a glance. The drawer for the eggs is immediately beneath the reservoir; it is provided with two small holes for ventilation, and holds about forty eggs. A small thermometer is also kept in the drawer to indicate the temperature of the air surrounding the eggs. A space is left around the reservoir, and on three sides of the drawer for a filling of sawdust or other non-conducting material. A flat tin lamp with two round wicks, is used by the inventor; but I see no reason why one properly constructed kerosene burner would

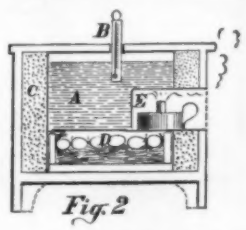
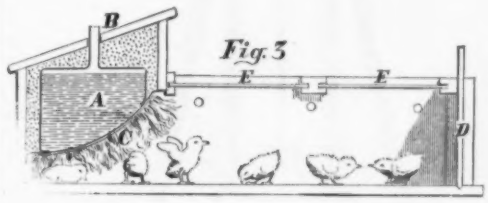


Fig. 2

not answer the purpose. A little soft hay is spread in the bottom of the drawer; the eggs are put in, it is then closed and warmed by the water above. The temperature of the water is kept at 122°, or enough higher or lower to keep the eggs at 104° to 106°. Once or twice each day the drawer is opened, and the eggs turned and left for a quarter of an hour in the open air before replacing. At the end of 21 days, the chickens come out of the shell without assistance, and are left 24 hours in the drawers, without feed, before being taken to the artificial mother. This operation follows the natural method exactly; the eggs receive their heat from above; they are turned each day, and are ventilated, as in the case when under the mother. The holes for ventilation in the drawer are very small, and probably could be dispensed with without inconvenience, as few will make the drawer fit air-tight.

"The artificial mother is also provided with a zinc reservoir of the shape shown in Fig. 3, it is covered below with a lamb's skin, in the warmed wool of which the chickens nestle and warm themselves. This reservoir is only filled in cold weather, and then only once a day, the water being first brought to a temperature of 100° to 175°. The tube passing up from this reservoir is used for filling, and the one at the side for emptying. The top of the box is of glass, arranged to slide so as to open at pleasure; there are three ventilating holes on each side, and a gate at the end. The chickens are placed in this when twenty-four hours old, and kept there for a week; they are then gradually habituated to the outside air—the gate being constantly open for them to enter at will. Fresh water and feed are given five times each day, it being considered essential to give only small rations, and to repeat them frequently.



This method of hatching and rearing chickens, which follows nature so closely, is used to a considerable extent in France, and is evidently satisfactory. Its economy in this country depends almost entirely on location. With oil at 13c. to 15c. per gallon, eggs could probably be hatched for about 1c. each. There is no trouble with hens leaving their nests, or losing their chickens with poor care; and with the non-sitting breeds the eggs laid during the period of incubation would pay double the cost of hatching a sitting. This of course only applies where eggs are worth 12c. or 2c. each, and a considerable number of chickens are raised. There can be no doubt that in such cases artificial hatching and rearing would pay well if properly conducted. The method of hatching by means of fermenting horse manure, advocated by Prof. Corbett, I have never seen in operation, but for very large establishments the plan, or some modification of it, might be found advantageous. On a smaller scale, however, and for all who wish for any reason to hatch artificially with little trouble and expense, I have never seen anything that would compare with the apparatus just described. For hatching high-priced eggs, such as are frequently sold at from 30c. to 50c. each, it would almost invariably pay.

NEW ARTIFICIAL LEATHER.

BY P. G. SMITH AND J. J. JOHNSON, HUNTINGTON, N. Y.

WE first reduce leather refuse, or chips and cuttings of tanned leather, to a pulpy state by subjecting it to the action of a mixture of sulphuric acid, pyroligneous acid, of about the strength known as seventy-grain vinegar, and fusel oil, or oil of whiskey, by which a thorough disintegration of the mass is accomplished, after which the surplus liquor should be drawn off, and may be preserved for a second or future operations. Rags and paper stock, of whatever nature, are next ground and reduced to pulp by any of the known processes. For mixing with these, a third compound is produced by heating oak bark (preferably the red oak) with vinegar, and mixing therewith a quantity of melted bees-wax.

The leather refuse, the paper stock, and the mixture of bees-wax and oak-bark are now thoroughly mixed and stirred together, and the surplus liquor drawn off. The resulting mixture is then steamed, which may be accomplished by introducing steam-jets at the bottom of the vat in any well known manner, after which the mass should be dried sufficiently to admit of its being ground.

The dried product is ground up finely, by which lumps remaining after previous steps are completely reduced, and the material thus prepared is again steamed, after which it is passed through sieves, to remove any remaining lumps and to facilitate the evaporation of moisture. From the sieves the compound is run under presses, where it is reduced to the proper thickness, and thence to rollers and hammers, under which its density is increased to any required degree.

The proportion of ingredients employed is substantially as follows: One thousand pounds leather stock; three hundred pounds rags; three hundred pounds paper; sixty pounds sulphuric acid; eighty gallons pyroligneous acid; twenty gallons fusel oil; one hundred and twenty-five pounds bees-wax; one hundred pounds oak-bark.

The bees-wax acts to give flexibility to the mass, which may be varied by varying the quantity used. It also operates to render the same water-proof, and assists in the thorough union of the several ingredients.

The oak-bark adds to the stock, and, at the same time, gives a color to the material which nearly resembles that of the natural leather when tanned.

The proportions of materials above enumerated are not invariable, but are about those preferred by us as giving the best results.

It will be observed that the article thus produced is comparatively without fiber and grain, and is therefore well adapted for uses to which papier mache is ordinarily applied. It is susceptible of being polished to a high degree, and may be colored either by mixing coloring material with the ingredients specified, or by painting, etc. These qualities render the material serviceable in the ornamentation of furniture and wood-work generally, the lighter parts of which it may replace.

CONVERTING CHLORIDE OF SILVER INTO THE METAL.

BY PROF. E. STEBBING.

PROCURE a porous earthenware tube, such as are used in galvanic batteries; make a zinc cylinder to enter it, leaving a small space around it. To the zinc cylinder must be soldered a piece of silver wire. A cork can be placed in the top of the tube to keep the zinc in its place, and wax poured over it to keep out the liquid. The chloride to be converted is placed in a large jar no more than half way up. The porous earthenware vessel is made to stand upon the surface of the chloride, and the silver wire is curved so that it can pass through the middle of the chloride. The jar is then filled with acidulated water, which, passing through the pores of the tube, attacks the zinc and creates an electrical current. The silver in a pure metallic state deposits itself round the silver wire.

The jar must be kept in a warm place, and not touched until every atom of the chloride is converted. When terminated it is not even necessary to melt the product in a crucible; it can be dissolved in nitric acid and crystallized. —*British Journal of Photography.*

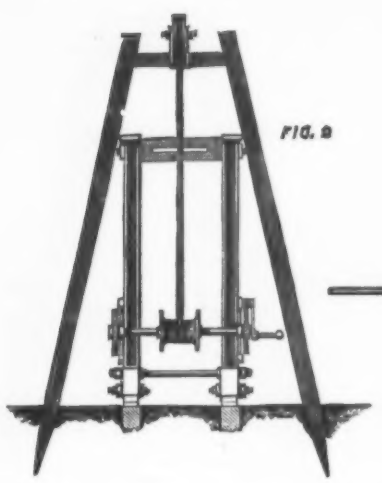


FIG. 2

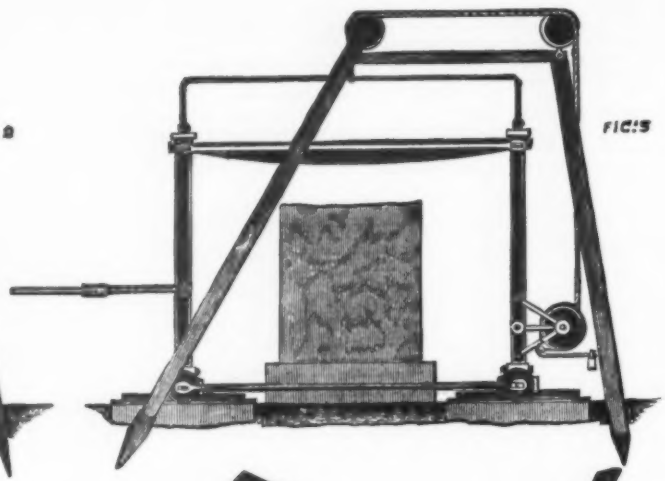


FIG. 3

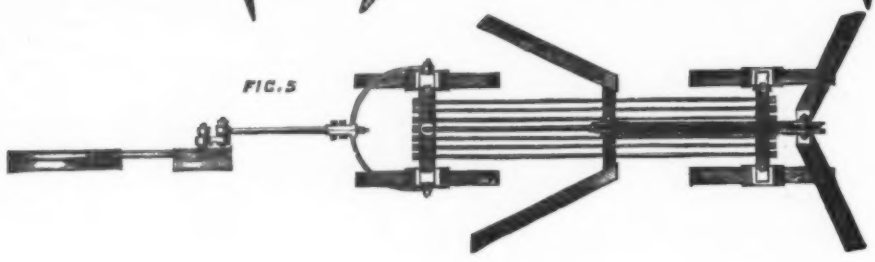


FIG. 5

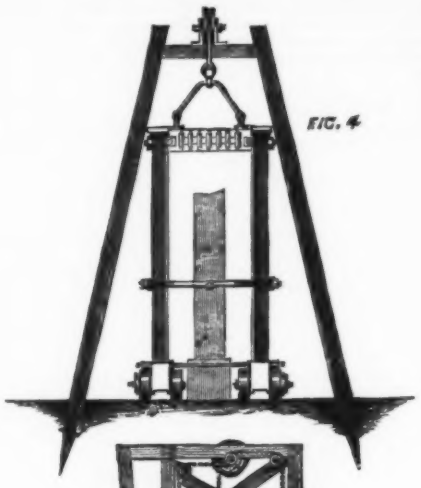


FIG. 4

FIG. 1

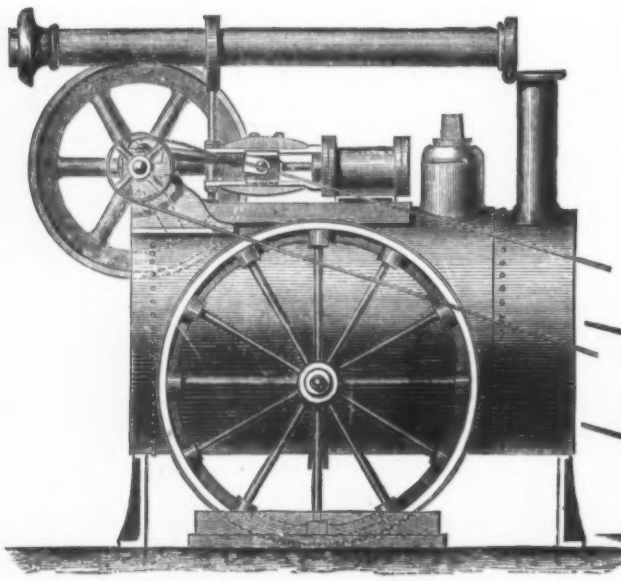
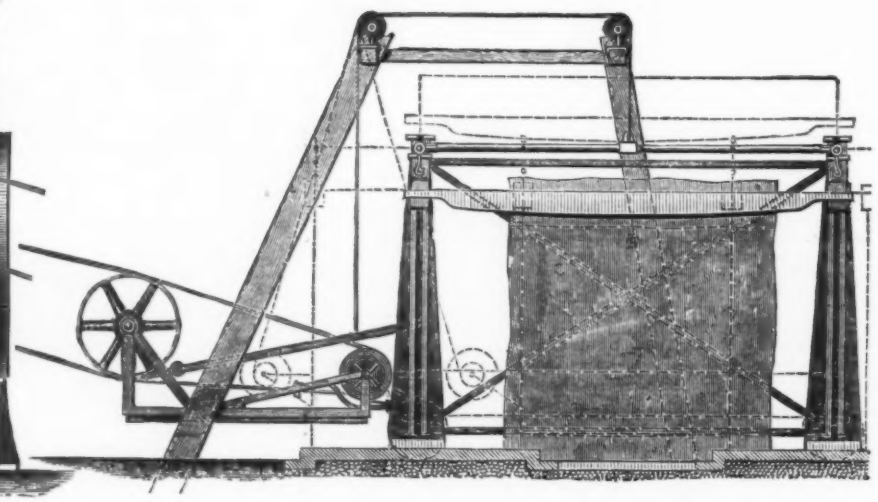


FIG. 6



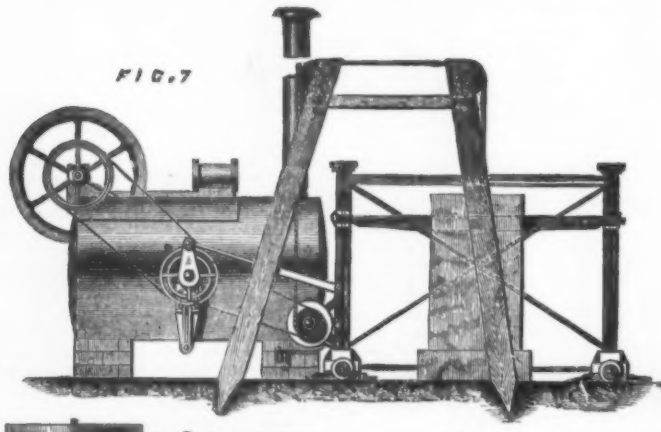


FIG. 7

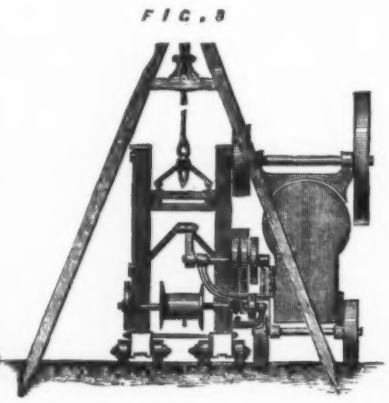


FIG. 8

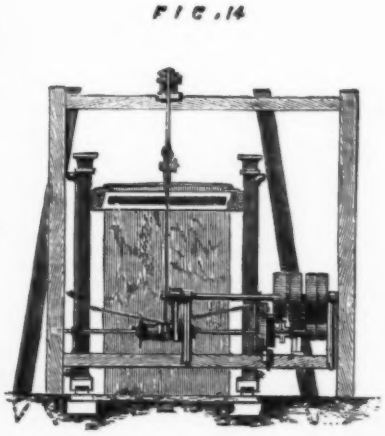


FIG. 14

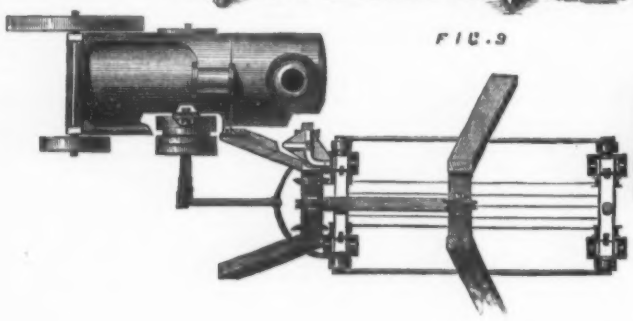


FIG. 9

FIG. 10

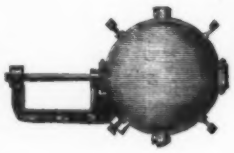


FIG. 11

MACHINERY FOR SAWING STONE.

STONE-SAWING MACHINERY.

At a recent meeting of the Society of Engineers, London, the following paper "On Stone-Sawing Machinery" was read by Mr. Henry Conradi :—

The question of stone-sawing machinery came first under the consideration of the author during the period when the building trade in Paris was at its best, which was when the Municipal Board of Works, at the request of the Imperial Government, took the necessary steps for improvement of the sanitary condition of that city. The removal of manufactories to spots some miles outside the boundary of the city and the reconstruction of those quarters which, through the narrowness of the streets, with their old and unhealthy buildings or factories, endangered the health of the population, was, in spite of the enormous sacrifices imposed, a measure of necessity. The operations incidental to these improvements occasioned a considerable demand for all kinds of building materials and labor. Everywhere large stone-yards were to be seen with the stone being cut and wrought by hand. But even those yards, although numerous, were unable to meet all the demands at the requisite time. Places were therefore hired where the preliminary work of sawing and cutting the stone were carried on. Even the building sites were arranged to serve that purpose during the excavation. Labor became scarce, and its cost increased rapidly, and contractors and builders experienced a serious want of machinery to help them in their stonework. It was then that the author was asked to design a machine for cutting marble and stone.

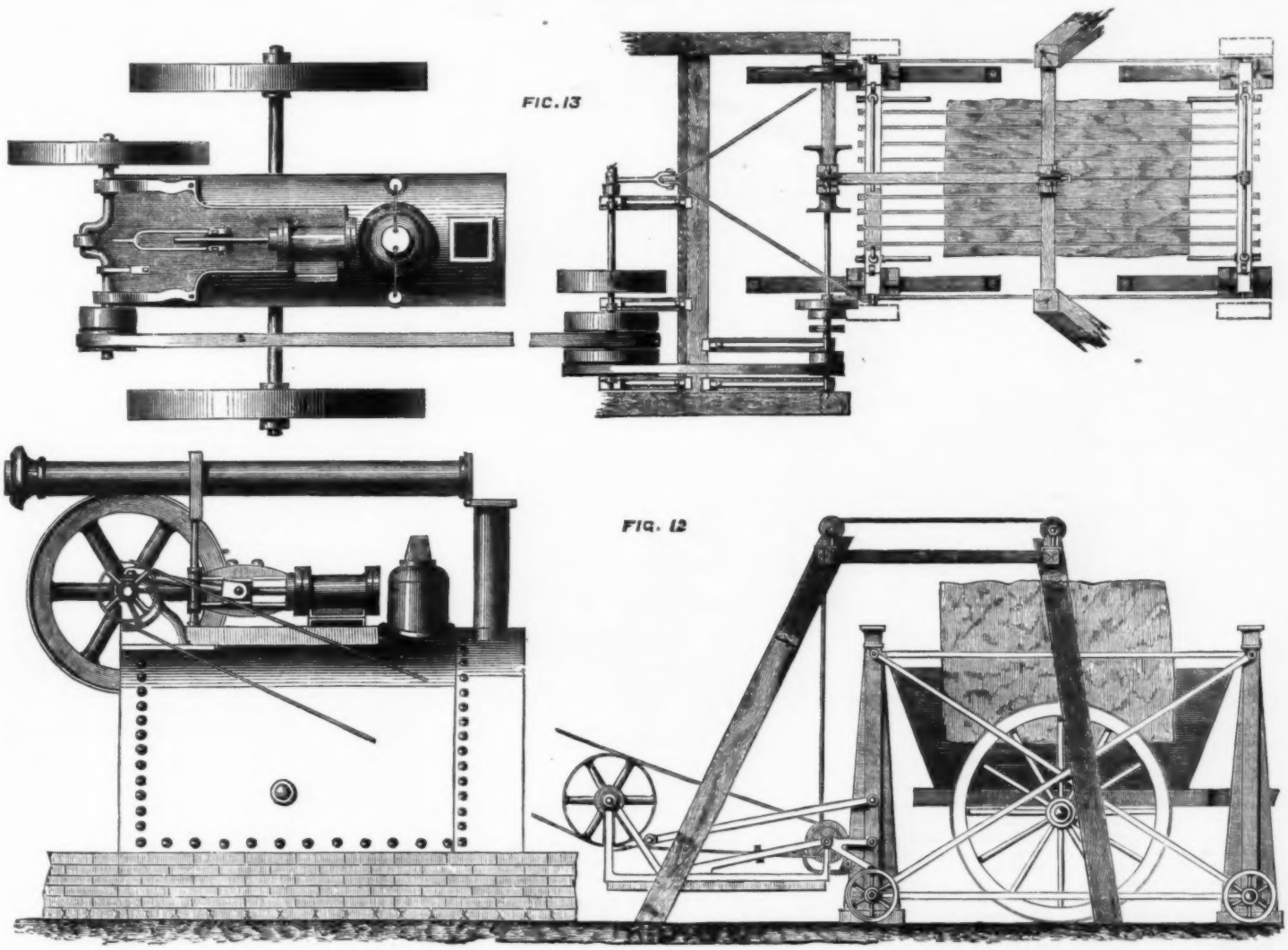


FIG. 13

FIG. 12

STONE-SAWING MACHINERY.

Before entering into a description of the machine he designed, the author will briefly describe the principal machinery generally used for sawing, planing, and moulding stone. The first operation which the block has to undergo if used for other purposes than foundations, is sawing into smaller pieces for handiness in working. In France, as well as in this country, wherever the author visited stone works, he found the same kind of machinery employed for sawing stones by the wet process. The operation involves mainly two motions, namely, a horizontal to-and-fro motion, and a vertical motion of the saws effected by means of a suspended boom, the whole system moving within a fixed frame or stand. The sawing or cutting operation is effected through the friction of the saws along the stone by distributing sand and water along the rubbing surfaces.

The machinery in use for sawing stone at the new Law Court buildings is shown in sectional side elevation at Fig. 1. Four timbers, of about 9 in. square and about 12 ft. high, are driven into the ground, and are united at the top by cross timbers and by outside diagonal timber bracings, forming a compact and solid stand. Between the stand, and fixed to the top cross timber, is vertically suspended a timber called the swinging boom. Between the stand moves the saw frame, which is suspended at its four corners to the stand by means of chains. On the top are the necessary pulleys and drums. The sawing frame consists of two longitudinal cast-iron arms, about 12 ft. long and 4 in. deep, which are provided at their ends with longitudinal openings to receive two wrought iron bars, which are about 6 ft. in length, 2½ in. in breadth, and 2 in. in thickness, between which the saws are keyed. One end of the saw frame on each side is provided with a small arm bearing a slide piece, which serves as its guide and connection by sliding in the vertical slotting which is fixed to the swinging boom, and comes into action by the down and upward motion of the saw frame. The suspension of the sawing frame is carried out as follows:—The chains attached to the end of the frame facing the swinging boom are coiled over and fixed to the drum which is placed on the front pillars, while another chain runs from the same point of the frame over the large pulley fixed to the shaft of the back drum, which is placed on the top of each pillar, carrying a counterbalance weight. The chains or ropes of the free back end of the saw frame are coiled over and fixed to the back drum, while again another chain, fixed at the same point of the frame, having also a counterbalance weight attached to it, is running over the large pulley placed on the shaft of the front drum. On each side of the stand are placed winches, from which end less chains are running over the large pulleys for winding up or lowering the frame with its saws. In a similar arrangement, but less complicated, the suspension chains—as shown in Fig. 1—run from the two corresponding points of each side of the frame to a central drum on which they are fixed. Over a large pulley fixed on the same centre shaft, but placed outside the stand, is suspended a chain with a weight to counterbalance the saw frame, while a second endless chain running over the outer ring of the same pulley sets it in motion, thus lifting or lowering the frame. The forward and backward motion of the saw frame, which is connected through slide pieces to the swinging boom, is effected through the connection of the latter with a steam engine or to a main shaft driven by an engine. The saws are of malleable hammered iron, about 8 ft. long and 5 in. wide, by ⅛ in. thick, plain-faced, without teeth. There are from five to ten saws, and sometimes even more, in one frame. The blocks to be cut are either carried to the machine by trucks moving on rails, or are placed in position by means of steam cranes.

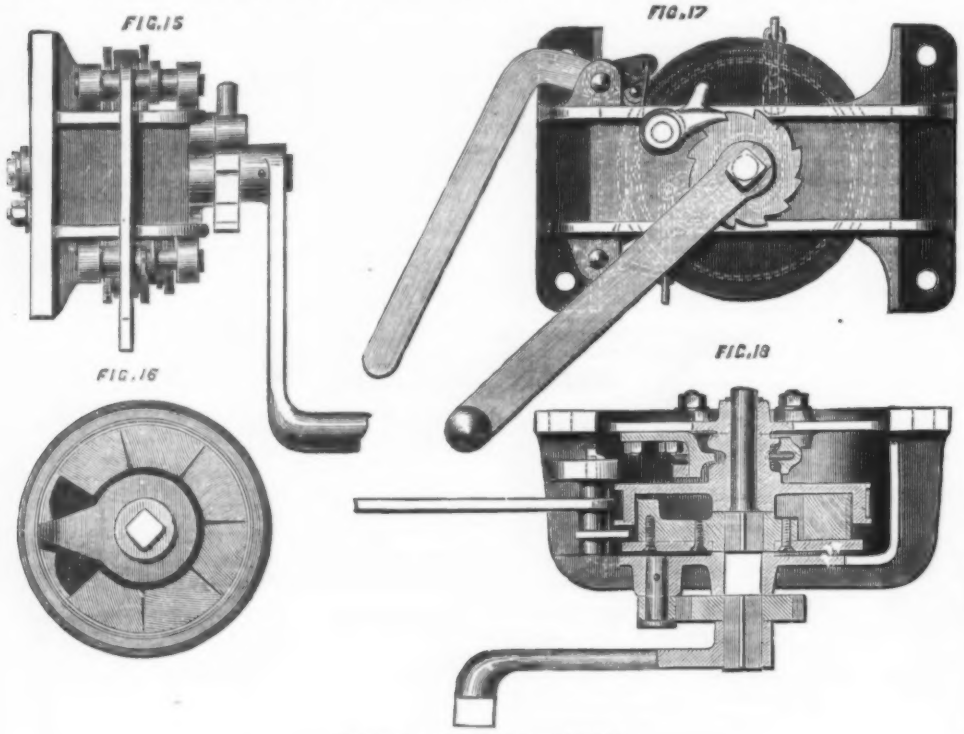
In opposition to the wet process stands the dry process of sawing—that is to say, sawing without the application of water. The author does not know to what extent machinery of this kind is used in France, but he thinks that building stones there being harder than the stones used here, the use of this kind of machinery will not be very extensive. The machines previously described are in use here, and the author had the opportunity of seeing them at work at the new Law Courts.

There were several powerful circular sawing machines having two horizontal saw discs. The machines consist of a strong cast iron frame to receive the requisite gearing. The saw discs are carried on vertical spindles and revolve horizontally. A strong vertical table can be moved backwards and forwards over the bed which carries the stone. The saws are adjustable vertically to suit the work. The saw disc has on its circumference a number of receptacles, into which the cutting tool is driven, the latter being a kind of steel nail, the head of which is shaped like that of a countersunk rivet, the edge of the conical head being the cutting surface. The stone is worked by the two saws from both sides. The machine is especially used for converting the blocks coming from the quarry into slabs or pieces of any size, and for squaring and facing them. These machines are constructed to work any size of stones, but are generally made for working stones of an average size from 6 ft. by 3 ft. by 3 ft. to 9 ft. by 4 ft. 6 in. by 4 ft. 6 in., and requiring from two to three-horse power to drive them. There is no doubt some waste of material, but this loss seems to be compensated for by using the dust for polishing the stones in the surfacing and rubbing tables. The author had further opportunity of seeing there a stone-moulding and a planing machine. They are provided with the same shaped steel cutter, placed in a series of tool-holders, fixed either on horizontal or vertical shafts. The stone is carried on a bed plate or travelling table moving backwards and forwards. A horizontal or a vertical shaft, called the cutter barrel, bears a series of tool-holders carrying the steel cutters, which are so arranged that the diameters of the different series of tools correspond to the outline of the required moulding. The tool-holders are placed vertically on the horizontal shaft and horizontally on the vertical shaft. The stone passes slowly the cutters at the rate of about 4 in. per minute. To finish the work the cutter shaft is raised, and a steel scraper of the exact form of the moulding is passed three or four times over the stone with an increased speed of about 12 in. per minute. The machine with the horizontal cutter works stones from about 6 feet by 2 feet 6 inches by 2 feet 6 inches to 9 feet by 4 feet by 3 feet 8 inches, with an average of from 2 to 3-horse power. The machine with the vertical shaft is adapted for working smaller stones, such as steps, string courses, and sills. The author saw fine mouldings carried out with these tools, but he believes that only the very best stones will stand the great strain brought upon them, as any impurity, softness, or hard fibers, will probably cause the stone to break. The surfacing and rubbing tables are composed of a strong revolving iron disc fixed to a vertical shaft. A circular iron trough is placed around the disc to catch the waste sand and water used. Timbers fixed above the disc divide it into compartments, in each of which a stone block can be placed, being held by the timbers while the disc revolves. The tables are from 8 feet to 14 feet diameter, requiring from 3 to 6-horse power to drive them.

The saw designed by the author was for the purpose of sawing blocks of costly marble into very thin slabs with as little waste as possible. The slabs cut out of the same stone were to be either of equal or different thickness, but were to have as nearly as possible a parallel cut. The machine was to occupy the smallest space possible, to be easily removed, and to be driven either directly by a steam engine or from shafting. Under these conditions the author came to the conclusion to reverse the principle of the marble and stone sawing frames generally used. The principle of the ordinary saw system consists mainly in a to-and-fro and an up-and-down motion of the saws, carried on by means of a freely-suspended movable boom attached to the engine, the saw frame being moved in a fixed frame. The author transforms the fixed stand into a movable one, carrying the saw frame with it in its forward and backward motion, the latter receiving its up-and-down motion by means of a suspension arrangement. The arrangement is shown in Fig. 6 in sectional side elevation. In the author's first design the frame consisted of four cast iron columns bolted firmly together at top and bottom, the front pair being directly connected to the engine by means of connecting rods, while the other pair was guided by means of a guide bar bearing on a chair placed behind it. They were provided with vertical grooves running inside from top to bottom for the reception of the saw bearers. For greater stability, and to obtain the cuts in the marble as straight and as parallel as possible, the columns run on square slides instead of rails, thus avoiding as much as possible the influence of vibration

to which the frame may be exposed through irregularities in the engine by the saws encountering layers of different hardness in the material to be cut.

The saw frame consists of two cast iron transverse beams provided with longitudinal openings for the reception of the saws which are keyed on one of the booms moving up and down in the grooves of the front columns, the other in those of the back columns, which are bolted firmly together, as shown in Fig. 13. The saw bearers are fixed to a longitudinal beam running from center to center of the saw bearers by means of vertical connecting rods, the beams being suspended by means of ropes or chains, which running over guide pulleys, are coiled round the drum of an ordinary hoisting crab, provided with a brake fixed on the drum shaft.



STONE-SAWING MACHINERY.

The brake is worked by a counterbalance weight on a lever, thus regulating the speed of the drum, and with it through the winding up or unwinding of the chain, the up-and-down motion of the saw bearers. At intervals of about ten minutes the attendant distributes the sand and water used for sawing, and also effects the lowering of the saw bearers and places the frame in equilibrium by altering the position of the counterbalance weight on its lever. The pulleys for the chains of the beam suspension arrangement are carried by chairs or plummer blocks fastened to the ceilings, the driving of loose pulleys being placed on the shafts. The saw frame works with five saws.

The practical difficulties found in setting the machine to work were the tightening of the saws and preventing the wear of the slide pieces from the water and sand falling on them. The first difficulty has been overcome by means of strong stays, which keep the columns and saw bearers at the required distances. The second difficulty was met by fixing a cover to the foot of the column, and thus preventing the water and sand spreading around.

As regards the stays of the saw bearers, they are usually straight wrought iron bars of about 1 inch in diameter. They are made curved in order to allow any size of stone to be brought under the machine, and to avoid making the framework of too great width. In some instances the author found that the sawing could be effected without fixing the stays to the saw bearers, if the nature or the stone did not require the saws to be very strongly tightened up.

With regard to the work done by the machine, the cutting being obtained through the pressure exercised by the saw on the stone, the grit used thus entering into the pores of the soft iron produces a rough cutting surface. The resistance of friction to be overcome along the rubbing surfaces, the travel of the saws and the pressure, are therefore the data to be considered. It is to be observed that some saws working with a swinging motion cut only four-fifths of their length, the saws being shaped accordingly, while others cut with their entire length. The pressure of the saws on the stone varies according to the softness or hardness of the latter, and it is not much greater in a steam saw than in a hand saw, as the greater pressure does not give a truly clean cut, but will rather tear pieces off the stone, or, if the material is too hard, will heat the saw. Therefore the saw is balanced until its pressure on the stone is equal to that exercised by a man, which the author assumes to be about 20 lb.

Assuming the engine to be making 120 revolutions per minute, and the travel of the saw to be about 5 feet, we have: Speed of saw = 120×5 feet×2 = 1200 feet. The coefficient of friction of stone on stone being = 0·71 in case of repose, that of motion being = coefficient of repose×0·7, we obtain, therefore: Work of cutting = 1200 feet × 20 lb. × 0·71 × 0·7 = 11,928 foot-pounds per minute. Assuming further, in round figures, the weight of the cast iron framework, with its accessories, to be = ½ ton, it follows that the pressure on the slides will, with 1 foot 6 inch stroke of saw, become 120 rev. × 2 × 1·5 feet = 360 feet of travel, thus the work produced = 360 feet × 1120 lb. × 0·18 × 0·7 = 50,803·20 foot-pounds, giving as the work of cutting = 11,928 foot-pounds, work of frame motion = 50,803·20 foot-pounds, a total of = 62,731 foot-pounds per minute, or $\frac{62731}{33000}$ = 1·90 H.P. Taking the frame composed of five saws, the work of cutting will be as above: 1200 feet × 20 lb. × 5 feet × 0·71 × 0·7 = 39,640 foot-pounds, work of frame motion as before = 50,803·20 foot-pounds, making a total of 110,443·20 foot-pounds, or = 3·34 H.P. per frame.

This result is somewhat higher as shown by practical results, the coefficient of friction and pressure on the saws becoming somewhat reduced during motion, and therefore losing some of their direct influence and amount by working several saws together. With one frame a stone from 6 feet to 8 feet in length will be cut, according to its softness, to a depth of from 2 feet to 2 feet 6 inches per day of nine hours. The machine designed by the author, and containing about three-quarters of a ton of cast iron, quarter of a ton of wrought iron, and from 30 to 35 cubic feet of timber, will cost, with its fittings complete, including wheelwork and saws, about £75. The price of the saws varies, according to the market, from £12 to £16 per ton; the price of the timber work being from £4 to £5. The author was prevented making further practical experiments with the machine in consequence of the outbreak of the Franco-Prussian war.

A further improvement made by the author consists in fixing the winding drum directly on the apparatus, and in setting the machine on rollers for the purpose of cutting ordinary stones, as shown in Figs. 2, 3, 4, and 5. This led the author to transform it into a portable machine, and to enable it by means of timber framing, bearing the suspension arrangement of the saw frame, to be used on open ground, and to be carried from one building site to the other, thus enabling the builder or contractor to have the stones cut directly on the spot instead of being sent to the stone sawing yard. The economy in time and labor thus obtainable is worthy of consideration. It is specially applicable for small buildings, where the contractor, after having the stones cut in one place, could send the machine to work at another place.

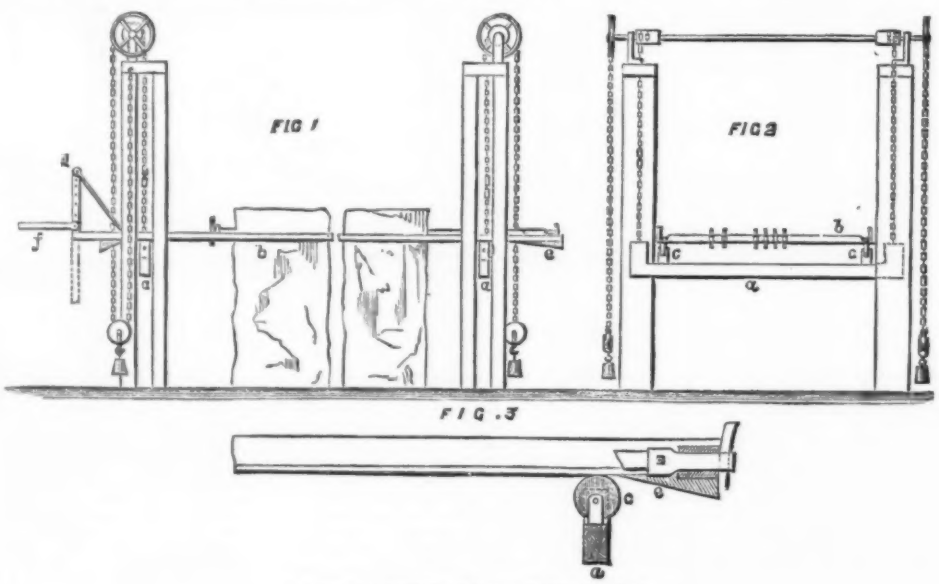
The author conceives the requirement of this kind of work to be fully met in this machine, the practical value of which is increased by providing it with a lifting arrangement, and in using the drum for the up-and-down motion of the saw frame for lifting and lowering the stone. The machine thus effects all the manipulations required. The stone coming from the quarry is carted directly under the machine, where it is lifted into position ready to be cut, and when finished is replaced in the cart to be taken away. The timber framing shown as driven into the ground, can also be placed on rollers and steadied by means of wedges or similar arrangements. The cast iron framework, as shown in Fig. 6, is placed on ordinary road rollers, travelling over ground laid with gravel. The lifting apparatus is fixed to a bracket provided with a shaft, and which is either fixed to the boiler of the engine in a temporary or permanent manner. In the former case several iron bands carrying the brackets are bolted to the boiler and secured by set screws, as shown at Figs. 7 to 11. A driving belt runs from the engine pulley to a pulley on the shaft of the lifting apparatus, where from another pulley another driving belt is carried to the driving pulley, which is keyed to the drum shaft of the saw frame.

During the operation of lifting or lowering the stone, the saw frame with its suspension arrangement is taken off, but the pulleys guiding the rope or chain being fixed to the timber frame remain. Instead of using a somewhat complicated arrangement of bracket and shafting, fixed either permanently or temporarily to the boiler, the author simplified this arrangement by fixing it to the timber frame, as shown in Fig. 6. An apparent difficulty here arises, the length of the bracket from the drum shaft to the timber frame forming an overhanging part of a long leverage. This has to be overcome by increased strength of material. Thus, considering this bracket as a cast iron girder, fixed at one end and loaded at the other, the load being represented by the pressure exercised through the weight of the stone to be lifted, while the distance from the timber to which the bracket is fixed to the center of the rope or chain which lifts the stone is to be considered as its lever. Assuming that a block of marble measuring 3 feet × 2 feet 9 inches × 2 feet 6 inches, has to be lifted, which corresponds to a weight of 1½ ton, and further that this weight acts with a leverage of 3 feet 10½ inches, the centre of the bracket shaft to the centre of suspension of the stone being 3 feet 10½ inches, and further that the above distance from the timber to the centre of the rope be 2 feet 3 inches, the length of the bracket acting as a lever, then we obtain as momentum pressure on bracket, 1½ ton × 3 feet 10½ inches = 13,020 with a leverage of 2 feet 3 inches, giving a momentum of 13,020 — 2·25 feet = 2?,295, say 13·5 tons; cast iron being safely strained in tension at 2 tons per square inch, it follows that $\frac{13{\cdot}5}{2}$ = 6·75, or in round numbers seven square inches will be the required section for the horizontal bar.

The author has shown by the dotted lines in Fig. 6, the different positions of the machine during its travel. The operation of lifting the stone from the cart and placing it under the saw frame is seen at Fig. 12, the stand being there represented for the purpose of cutting stones on road rollers, showing that there is no difficulty in moving the sawing apparatus placed on slides or on rollers, the machine being arranged so as to allow the one to be replaced through the other, according to the kind of work to be executed. After the stone has been placed the lifting apparatus is thrown out of gear by uncoupling the whole arrangement or by shifting the driving belt on a loose pulley, as shown in Fig. 13. The shaft of the lifting arrangement is provided, as shown in Fig. 13, with a fly-wheel, but as the operation of lifting and lowering the stone takes only a very short time, the author thinks that these operations could be effected without it and with a gain in economy. The saw frame, consisting of its bearers and saws, as shown in Figs. 12, 13, and 14, the beams are then put in position by attaching the ropes, which have again become free, to the suspension arrangement. The machine is then set to work until the cutting is finished, when the suspension arrangement and the saw frame are again taken away and the lifting apparatus thrown into gear to lift the stone on to the cart to be carried away.

The engine is two-wheeled and of two horse-power, such as is frequently used by contractors in France. It is of great simplicity and solidity, working expansively at two-thirds of its stroke at 120 revolutions per minute, with a consumption of 15·5 lb. of coal per hour, its price being about £70. The engine can be placed standing on its wheels, or the wheels can be taken off and the engine placed on a foundation.

The author considers it necessary that a safety apparatus should be attached to the lifting apparatus to prevent accidents. Figs. 15 to 18 show an apparatus of this kind, the invention of M. Mégee, and which is in use in France. It consists of a box-shaped loose pulley, containing a cylindrical spring covered with leather, which presses against the internal sides of the pulley. This spring is provided with a number of projections against which works an internal cam, which is fixed to a disc keyed on to the same shaft as the loose pulley. By turning the shaft the disc turns with it, imparting its motion to the spring, which, through its friction against the inside wall of the loose pulley, imparts its motion to it. To the side of the loose pulley is partly cast on, and partly bolted to the frame, the receptacle for the chain. By turning the handle in one direction, say to the right, the spring being pressed against the pulley produces its motion, drawing the chain, and therefore lifting the load, this loose pulley being in the meantime under the constant control of a continuously acting brake. For lowering the load the outside break is loosened, the loose pulley being actuated only through the weight of the descending load, the descent being regulated by the man in charge governing the lever of the brake. The operation of lifting is therefore conducted by turning the main shaft by means of its handle, and governed through the friction of the internal spring, thus preventing too heavy a load being taken, as the excessive friction of the internal spring against the loose pulley would prevent the latter from moving. The operation of



DARBY'S STONE-SAWING MACHINE.

lowering loads is conducted by the free motion of the loose pulley governed by the outside brake, the advantage in the latter case is that of keeping the main shaft at a stand, thus preventing the handle turning, and accidents occurring to workmen in lifting or lowering. In ordinary winches, the handle may suddenly turn, or, slipping out of the hands of the man, injures him, the load breaking down in its rapid fall. In the case of the Mégee pulley, the workmen has only to leave the apparatus to itself; the heavy strain from the slightest rapid descent of the load brought on the loose pulley imparts the same to its internal spring, producing considerable friction between both, thus bringing the falling load to a stand.

Apparatus for heavy loads for steam power constructed on the same principle is provided with the necessary gearing. The author has observed that oil or water brought between the rubbing surfaces, instead of diminishing the friction between the pulley and the spring, increases it; the reason being that water or oil makes leather swell, the coefficient of friction being about 0·20.

We add to the foregoing illustrations of stone-sawing machinery, the devices of Mr. F. Darby, of Freeman's Stone Wharf, Deptford, a very simple, but efficient though roughly made machine, which he has used at the above wharf for about four years. During this time the machine has cut between 70,000 and 80,000 superficial feet of stone, principally Portland, and most often in pieces of large size. Mr. Darby's apparatus cost him only about £20, and although it is a roughly made tool, it is not very likely that it could be repeated for less than 50 per cent. more than that amount.

We give a rough illustration of the machine, which is, in its simplicity and efficiency, an example of the excellent "makeshift" which men thoroughly versed in the practice of the work to be done, and with sufficient mechanical skill to carry out their ideas, sometimes bring forward to accomplish an object. It will be seen that the machine consists principally of four uprights, each made of two semi-balks placed sufficient distance apart to admit of the vertical motion of the cross-bearers, *a*, carrying friction rollers, *c*, upon which the saw frame reciprocates. The latter consists of two longitudinal pieces of angle iron connected together at the ends by two pieces of flat iron, as shown at Fig. 2, which form the means of holding the saws at different or equal distances apart. The saw frame is thus very light, and requires little power to move it. It will be seen from the figure that the bearers, *a*, are suspended from chains running over short barrels mounted, at the top of the uprights, on shafts, carrying also grooved pulleys, over which run chains from balance weights, by means of which the whole or any portion of the weight of the saw frame and saws may be brought to bear upon the cut.

The simple manner in which the saws received the necessary lift at each end of the stroke to allow the sand to run under their edges is the point most worthy of remark. At the under side of each end of the saw frame is fixed a wedge-shaped piece of wood covered with iron, forming an inclined plane, *e* (Fig. 3), which at each end of the stroke runs up on the friction roller *c*, thus lifting the saws and allowing of the supply of new sand to the cutting portions just as they begin a new stroke. The vibrating arm, *f*, from the engine, by which the saw frame is moved, is attached to a flat bar, *d*, with several holes in it, into which the pin connecting the vibrating arm, *f*, therewith, may be shifted as the saws descend into the block of stone. This vertical bar is firmly stayed, and in such a manner that it may be readily fixed in the position shown by the dotted lines, so as to keep the end of the arm, *f*, at such a level, that it may not tend to lift the saw frame when it is on the top of a large block of stone, nor throw any pressure in an oblique direction upon it when at the bottom of a block. The end of the arm, *f*, is attached to a crank pin, the shaft carrying which is of a fixed level, so that the angle which would be assumed by the arm without some such arrangement as that described would be occasionally sufficient to greatly decrease or increase the pressure on that end of the saws when at the top or bottom of a block respectively.

In the case of the machine described, the engine of the 13-ton crane which commands it also works the saws. The engine is about 2½ horse-power, and with it this rough machine will cut 100 superficial feet of hard Portland stone in ten hours. About seventy strokes per minute is found to be the best speed, and 16 inches to be the best length of stroke, the sand being worn out after having travelled that distance. Feeding in the sand by hand-supplied water is adopted, as the saws most needing it may be given a larger quantity.

We are indebted to *The Engineer*, London, for the foregoing illustrations and information.

In this country, the introduction of circular saws for stone cutting is being attended with much success, resulting in economy of time and power.

THE WHEELER & WILSON SEWING MACHINE EXHIBIT AT THE CENTENNIAL.

AMONG the many exhibits at the Centennial upon which almost unlimited pains and expense was lavished to make the displays as attractive as possible to the visitors, none, as a class, excelled those of the several sewing machine companies. Elegant pavillions, furnished in princely style, and glittering with all that paint and gilt, in the hands of artists, could lend to the beautyfying of them, were to be seen for nearly half the length of that vast building, Machinery Hall, to say nothing of those elsewhere upon the grounds, and these were loaded with sewing machines of every conceivable variety and grade of value, as well as with costly and elegant specimens of the almost endless variety of work done upon them. Then there was a small army of both sexes in attendance upon them, skilled in their use, and in each particular case working like beavers to convince the passers by of the superior merits of their machine in some one or more, or in all respects. The expense attending such magnificent preparations, and their subsequent conduct through the six months the Exhibition was open, was, in the aggregate, something enormous, and serves to establish the fact, that in no other branch of mechanical industry does there exist a more thorough and decided competition. Next to those great civilizers, the steam engine and telegraph, the sewing machine has wrought a greater revolution in human affairs than any piece of mechanism produced by man. It has been the subject of more earnest study and persevering experiment, and been the source of more patents than any other machine whatever, not excepting the steam engine; and as a means of the enrichment of inventors it has far exceeded any field of labor for that class of men—of which this country has been so prolific. The influence which the sewing machine has exerted in ameliorating the internal affairs of the household, and saving the time and labor of the feminine portion of the community for better and more ennobling pursuits than the drudgery of the needle, will appear under due thought upon the matter as something most extraordinary in its results; while, in the factory, the effect of its use in increasing the productions of man and woman is beyond computation; and it would be no exaggeration to say that, without the sewing machine to-day, the amount of work of the severest practical nature, and as seen in the extraordinary amount of embellishment in shape of embroidery, ruffling, quilting, fluting, stitching, etc., nowadays necessary to the completion of the fearfully and wonderfully made habiliments of the woman of the period (and the man of the period, too, for that matter), all the women in the world, working all their waking hours with the needle, would fail to accomplish the task of doing an equal amount of such work. The sewing machine is, in a word, next to the steam engine, the great labor saver of the age; any very decided and well established advance made with this machine is, therefore, worthy the careful study and consideration of those interested in it; and that includes everybody capable of thinking.

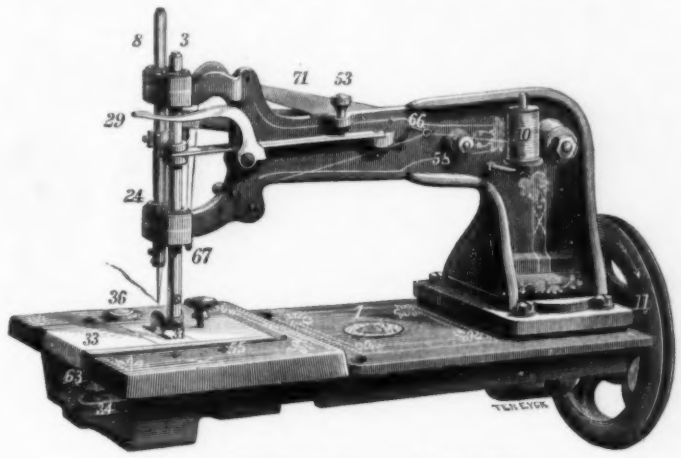


FIG. 1.—GENERAL VIEW OF MACHINE.

Among the magnificent exhibits mentioned above was that of the Wheeler & Wilson company; and, in illustration of the very great progress made by this concern, I herewith give your readers twelve figures showing the construction of the particular machine which embodies their latest achievements in this direction; the machine known as the "No. 6."

It would not be just to them, however, to infer that their display was confined to that made by them in their particular space in Machinery Hall, for really there was scarcely a building on the Exhibition grounds in which they did not make more or less of an exhibit. In the Main Building it would have been difficult to find an exhibit which contained work capable of being executed on the sewing machine, without something done upon the machines of this company; while in the Shoe and Leather Building, where was to be seen, perhaps, the most extraordinary display of ornamental leather work ever assembled under one roof, the notice: "This work was done on the Wheeler & Wilson machine," was to be seen on every hand. The display, therefore, made by this company at the Centennial was, as a whole, one of the most extensive made by any individual concern.

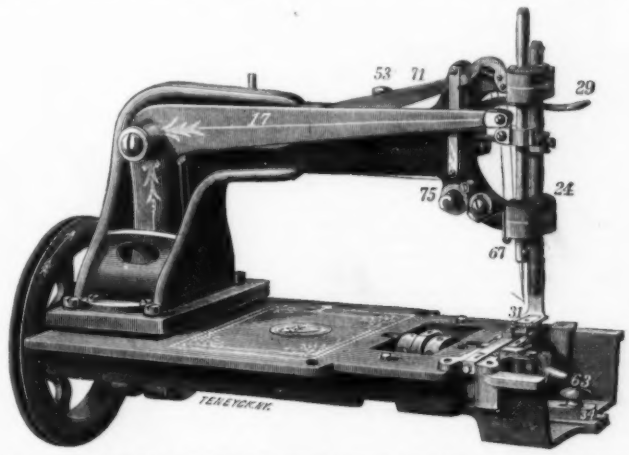


FIG. 2.—VIEW FROM REVERSE SIDE, WITH CLOTH PLATE REMOVED.

In Fig. 1 is seen the No. 6 machine, except the table, driving gear, etc., and the numbers in this, as in all the figures, indicate the different working parts. The machines known as the Nos. 7 and 8, specially adapted to certain purposes, are mainly the same in construction as the No. 6, so that a description of the latter will essentially cover the three. The No. 6 is the machine which is intended be capable of meeting any ordinary demand, and is a general embodiment of their most valuable and recent improvements; and such is the range of capacity of it that, with the same machine, one can at one minute sew the heaviest leather work, and at the next the finest of ladies' wear.

Fig. 2 shows the machine from the other side, with the cloth plate removed; Fig. 3 gives a view of the machine from beneath; Fig. 4 is a perspective view of the needle and "take-up" cams; Fig. 5 illustrates the variable motion mechanism; and Fig. 6 the same in section; Fig. 7 shows the washer, rotating hook, bobbin and case, detached from each other to exhibit their separate forms; Fig. 8 gives a view of the hook entering the loop of the upper thread; Fig. 9 shows the arrangement of the upper tension; Fig. 10 illustrates the action of the under tension; Fig. 11 is a view of the feed mechanism; and Fig. 12 the machine complete.

The cast-iron bed-plate, Figs. 1 and 2, upon which the remainder of the mechanism is supported, is numbered 1, Upon this is secured the fixed arm, 6. This arm is bifurcated at its front end to form bearings for the hollow needle bar, 8, and presser bar, 3. These bearings contain chambers which are packed with felt washers, to be kept saturated with oil, which is done through the oil cups, 24, which surmount them. The lubrication of these bars is, in this way, perfectly accomplished without the slightest danger of soiling the goods under operation by the dripping down of the oil. The needle and "take-up" levers are pivoted to the fixed arms, as shown in Fig. 2; the former being bent at a right angle at the center, upon which it has motion, and the needle bar, 8, is connected to it by a short jointed link to compensate the reversed sink of the arc described by the extremity of the needle lever. The other extremity of the needle lever receives motion from the peripheral part of the cam seen in Fig. 3, and shown enlarged in Fig. 4. The lower end of the needle lever is marked 30 in Fig. 4, upon which will be seen a stud carrying a roller, which engages the groove in the periphery of the cam. At the upper end of the "take-up" lever is a small sheave or "rolling eyelet," upon which the thread passes on its way to the needle; and upon its lower extremity, as shown in Fig. 4, a connecting rod, 73, descends to an appropriate formed groove, 5, in the face of the cam. The end of this connecting rod is slotted to pass over the shaft, 12, upon which the cam is secured; and upon its lower extremity is seen a stud and roller engaging the groove. The band wheel, 11, Fig. 3, is also secured to the shaft.

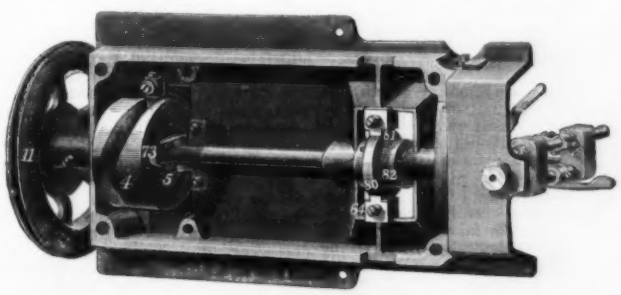


FIG. 3.—VIEW OF MACHINE FROM BENEATH.

While the shaft, 12, with the cam, 4, and the band wheel, 11, is given a uniform motion, the rotating hook is alternately

accelerated and retarded by an ingenious contrivance, seen at 80, Fig. 3, and in detail in Figs. 5 and 6. A ring, 80, having upon it, at opposite sides, lugs, by means of which it is secured to the under side of the bed-plate, carries within it a disc, 81, having two opposite radial slots cut through it. This ring or yoke is secured to the bed-plate in such position that its centre is disposed eccentrically to that of the shaft, 12, and a virtual extension of it, 18; which latter carries the rotating hook. Upon the adjoining ends of shafts 12 and 18 are secured small disc couplings, from the faces of which project studs, 35 and 36, the projecting ends of which are of such form as to fit the slots in the disc 81, while that portion

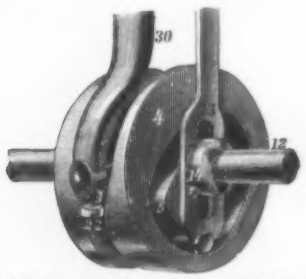


FIG. 4.—PERSPECTIVE VIEW OF NEEDLE AND "TAKE-UP" CAMS.

of them entering the couplings are cylindrical, to permit of a necessary slight oscillation upon their axis. The principle of this mechanism is identical with the well-known Whitworth variable motion for slotting and planing machines. As shown in the figure (5), with 12 as the driving and 18 as the driven shaft, it is placed in the position in which shaft 18 has its minimum motion, and from this point its rate increases until a semi-revolution is reached, when it has its maximum velocity; the reverse of this obtaining for the other half revolution. The amount of variation given to the hook shaft, 18, is governed by the distance of the pins from the centers of the shafts and the eccentricity of the slotted disc; and in this machine it is so proportioned as to make the greatest angular velocity of the rotating hook about 9 times that of the least. In this way its fastest ⅛ of a revolution is performed in ¼ the time required to a complete revolution, while the slowest ¼ of a revolution requires for its performance ⅝ the time for a whole revolution.

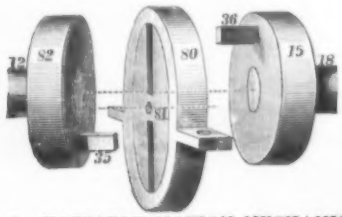


FIG. 5.—VARIABLE MOTION MECHANISM.

The rotating hook, Fig. 7, is a peculiar piece of mechanism; in this machine it is made so deep as to receive a bobbin which is capable of holding a much greater quantity of thread than is usual with the ordinary shuttle bobbin. A continuation of the circle of the hook is plainly shown, passing by and overlapping the hook to act as a guard, preventing the thread from the bobbin from interfering with the newly-formed loop of the upper thread. The case is made to cover one side, and the thread groove between the flanges of the bobbin—being sufficiently large in diameter, however, to permit of the thread passing out from under its flange—so that the loop of upper thread may pass unobstructedly around the lower thread, and to insure that it does not fall into the groove of the bobbin instead of passing over it, to be drawn upward by the "take-up." This case is held in place by a vertical projection from the sliding piece, 34, Fig. 2, which is secured in place by the milled screw, 63; bearing upon the case by the pressure of a light spring. This is more clearly shown in Fig. 10.

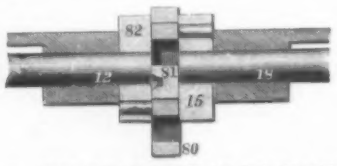


FIG. 6.—VARIABLE MOTION MECHANISM, IN SECTION.

Fig. 8 shows the point of the rotating hook, 1, entering the loop of the upper thread, while the tail or overlap of the hook, 2, is seen pressing the lower thread out of the way. In the operation of the machine the needle in its descent carries with it through the cloth a "bight" of the upper thread, from which the loop shown in Fig. 8 is formed as the needle begins to be withdrawn. Continuing to rise the needle pauses at a point where its point just clears the periphery of the hook, its eye being still below the fabric. During this pause in the ascent of the needle the "take-up" lever descends sufficient to permit of a loop of the upper thread passing around the bobbin, where it is carried by the hook; and it is during the accelerated part of the revolution of the hook, as above described, that this is done. By the time that the loop of upper thread has been carried entirely around the bobbin and is cast off the hook, the needle is withdrawn entirely out of the fabric, and the stitch is at this point completed by the "take-up" drawing up the loop. The retarded portion of the revolution of the hook is performed between the casting off of one loop and the formation of the next, and this is done, as shown, while the "take-up" is drawing up the loop.

Fig. 9 shows the contrivance for regulating the tension of the lower thread. The washer, 1, rotates with the hook; upon it is seen a projecting lug or "pad," 2, which extends over the periphery of the hook. The plate, 4, is secured to the bed of the machine, connected to this plate by dowel pins, to permit of its rising from the plate is a perforated finger, 3. This finger is held down upon the plate, 4, by the thin lever 5, which is adjustable to varying positions upon a flat headed pivot, as shown; the finger acting as a spring variable in its tension accordingly as the lever is placed more to the right or the left, to press the perforated end of the finger upon the pad, 2, when the latter comes in contact, the needle and lower thread both pass through the perforation in the finger, and at the time of contact between the "pad" and finger the under thread is clamped between them and held with a force governed by the position of the lever, 5, at the time. And this clamping of the under thread occurs, as shown above, exactly at the time of the tightening of the upper thread loop by the "take-up." The action of this under tension is shown in Fig. 10.

The feed motion, seen at Fig. 11, is a modification of A. B. Wilson's four motion feed, so universally used. By the action of the cam, 39, the feed bar, 7, carrying the serrated block, 26, is at the right hand end alternately raised, moved forward, and dropped at each revolution of the hook, the spring, 38, imparting to it its backward motion; keeping it against the face of the cam, 59, or the eccentric stop, 27, as the case may be. The eccentric stop regulates the length of

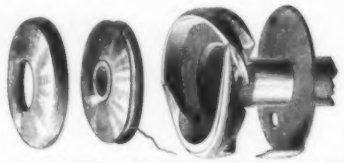


FIG. 7.—ROTATING HOOK AND ITS ADJUNCTS.

the stitch in the usual way. The presser bar, 3, is so constructed that either a roller presser for leather work, a flat steel one for cloth, or the glass presser foot used for ordinary sewing may be attached as desired; and similarly the feed bar is made to receive different serrated blocks adapted to different pressers, or the kind of work to be done. Provision is also made for the ready attachment of the various devices for special kinds of sewing, embroidery, etc.

The difference between this machine, perfected as here shown, and the original Wheeler & Wilson family machine—which in its day was regarded as a triumph in this line—is as great as that between the latter and the first sewing machine ever made, and the improvements are much more important than would appear from a casual examination. The great advantage of the rotary method of passing the under thread through the loop of the upper was early recognized in this machine, and particularly its capacity for rapid work. It is one of the most self-evident of propositions that a more easy and rapid motion may be imparted to a revolving than to a reciprocating body, and with less wear and tear. There is no loss of power in the mere conversion of rotary into reciprocating motion, or *vice versa*, it is true; for the power absorbed in the reciprocating steam engine, for

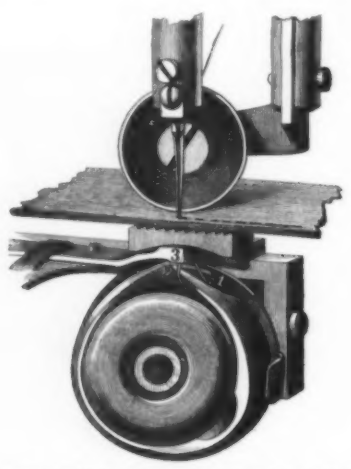


FIG. 8.—THE HOOK ENTERING THE LOOP OF THE UPPER THREAD.

instance, in putting in motion the mass of metal constituting the piston, piston rod, cross-head and connecting rod in the first quarter of the revolution of the crank is given out again upon the crank pin by bringing to rest this mass during the second quarter of the revolution, and similar conditions hold good where the transfer is from a rotary to reciprocating motion, as in the shuttle of a sewing machine receiving this motion from a rotating shaft. The stopping and starting of heavy masses of metal, however, though moving slowly, or light masses moving rapidly, is productive of greater strains upon the transmitting mechanism, as well as upon the moving masses themselves, and the result can only be a far greater amount of distinctive wear in all joints, noise as soon as any wear takes place, disagreeable vibration in the whole structure when the reciprocation is rapid, and an increase of friction upon the joints through the greater pressures brought upon them at or near the time the change of direction is made. In this view the rotary hook must be capable of performing a given number of stiches per minute with greater ease and more durably than with any reciprocating method

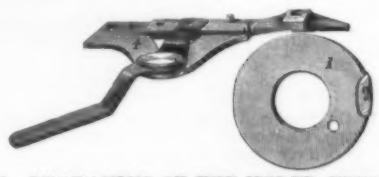


FIG. 9.—MECHANISM OF THE UNDER TENSION.

whatever. The truth of this proposition is seen in the history of many machines; to dispense with reciprocating parts for the reasons in part above given, has led inventors so persistently to a search for a rotary form for the steam engine; the enormous difference in speed between all kinds of printing presses of the rotary type and those having reciprocating type beds, is due to the great difficulty in controlling the reciprocating bed at high speeds; the circular saw and many other familiar instances might be adduced. In all the improvements made in the Wheeler & Wilson machine, therefore, this fundamental part of the system has been retained, and this, with the four motion feed and the wheel tension for the upper thread, are the only parts of the old family machine which has been retained in the Nos. 6, 7, and 8 machines.

The curved needle, rigidly attached to the end of the needle lever, has been supplanted by a sliding needle bar, made hollow for strength with minimum of metal, carrying a straight needle, driven as before described. The "take-up" is an

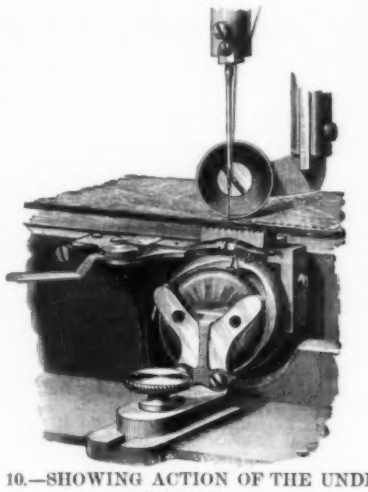


FIG. 10.—SHOWING ACTION OF THE UNDER TENSION.

addition entire, enabling one stitch to be completed before commencement of another; whereas in the old machine one stitch was perfected by the expansion of the loop in passing over the bobbin for the succeeding stitch, a method which was suitable only for a narrow range of work, and entirely inadmissible upon leather and heavy fabrics. In order to produce a perfect lock stitch in every case the "take-up" was made to finish the drawing up of the loop after the needle had entirely risen out of the goods, and in order that this could be done between the disposition of one loop and the entering of the next by the rotating hook, the latter was given the variable motion. The means of regulating the tension of the under thread, and thus insuring that the point of contact of the two threads may be brought to any point in the goods which may be desired for the kind of work in hand, is a most simple, ingenious and admirable contrivance. The perfection of the stitch by the "take-up" after the needle

FIG. 11.—THE FEED MOTION MECHANISM.

has left the goods, permits of the use of larger cotton than could otherwise be done; the needle hole in the goods is thus more nearly filled with thread, and this renders possible the making of a perfectly water-tight stitch. There being no tension upon the under thread, except at the moment of the tightening of the stitch by the "take-up," the stitches may be varied in length at will without interfering with the position of the lock or puckering the goods; and there being no tension on the lower thread while the cloth is being moved by the feed, the spacing of the stitch is not obstructed, and becomes as perfectly done as though laid off by a dividing engine, no matter whether the stitch be coarse or fine. This momentary action of the under tension also permits of the

FIG. 12.—VIEW OF THE COMPLETE MACHINE.

passage from thick to thin goods, or from parts of a garment where three or four thicknesses of the goods are required to be sewed together to others where but two thicknesses occur, without change in any part of the machine, and the perfect locking of the stitch within the goods in the one case as in the other.

The thick bobbin is a most decided improvement, either as holding a greater quantity of thread at one filling, or as holding a thick cord instead, such as is used on the under side in making button-holes in leather and other fabrics. Very great care seems to have been taken to insure an easy access to all those parts of the machine necessary to reach in the ordinary working of it, and thus all the preparatory operations which require the machine to be at rest, and thus detract from the time of actual operation, may be done in the shortest possible time.

Some of the tests to which this machine was subjected by the judges will be interesting as serving to illustrate its capacity and many strong points; some of them, indeed, are not less than wonderful. One of the tests was, to stitch book muslin with No. 400 cotton at the rate of 600 stitches per minute. To test the ease with which it runs, two thicknesses of muslin were stitched together with No. 60 cotton at a speed of 600 stitches per minute, with the same cotton used as a driving belt. On patent enamelled leather, and without injury to the surface, lines of stitching were made containing over 100 perfect stitches to the inch. Bags of both India rubber and kid were stitched perfectly water-tight at the seams. As tests of the heavy material which may be sewed by it: In one case twenty thicknesses of "butternut" duck were sewed together, and in another case six layers of tin, alternating with seven thicknesses of heavy broadcloth, were all stitched together without any previous puncturing of the tin. To test the variation in thickness of the work which is permissible without change in the adjustment of either tension, seams were made passing successively from one to three and four thicknesses of leather, thence to muslin and to the thinnest tissue paper. Calf skin and India rubber were sewed together, and the feats of making seams with copper wire instead of thread, and using a purposely knotted under thread, were successfully performed; and the machine was finally run at a speed of over 2,000 stitches per minute. In a reciprocating shuttle machine this would necessitate 4,000 single excursions of the shuttle per minute, or 66⅔ in a second of time.

The following are the three reports of the judges, given as bases of a similar number of awards for this machine.

REPORT No. 1.

"The new Wheeler & Wilson sewing machine, making a lock stitch, and employing a straight needle, moved by a vibrating arm and grooved cam; also a disc bobbin and rotary hook, the latter having a varying speed of revolution, by means of a divided shaft, with connecting disc.

"For the following reasons:

"A lock stitch machine, unsurpassed in the fine workmanship of its parts, and possessing great originality, great adaptability to different classes of work, both in cloth and leather, beauty of stitch, ease and rapidity of motion, and completeness of display."

REPORT No. 2.

"Sewing machine for leather.

"For the following reasons:

"Superior quality of work in stitching leather."

REPORT No. 3.

"Sewing machine needle work.

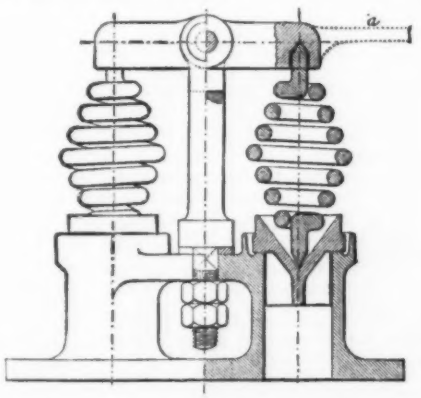
"For the following reasons:

"A superb display of needle work executed upon the Wheeler & Wilson sewing machines, exquisite in design and finish, from the lightest gauze to the heaviest leather."

This machine stands to-day as the embodiment and refinement of over a quarter of a century's persistent and persevering improvements, and as a specimen of American ingenuity and skill in the adaptation of means to ends it reflects the highest credit upon our country, its inventors and mechanics. The sewing machine is preëminently and almost exclusively an American production; and the vast amount of ingenuity and inventive talent expended upon it in its multitudinous forms, has made an enviable reputation for us abroad, places the American in the forefront among mankind as mechanic and inventor, and no one of its many forms lends more to this result than the new system of the Wheeler & Wilson company. J. T. H.

SPRING SAFETY VALVE.

WE illustrate below a very neat arrangement of spring-loaded safety valves designed by Mr. Martin Atock, locomotive superintendent of the Midland Great Western Railway of Ireland, on which line the valves are in use. The casting forming the safety valve seat is fitted with a pair of valves bearing on rather wide flat faces, the valves slightly overlapping these faces, as shown. Between the valves is a standard forming the fulcrum for a lever, between the ends of which and the valves steel springs are interposed. These springs terminate in points which bear in recesses in the valves and lever respectively, the point at which the spring



bears in each valve, being below the level of the valve face, as shown. When desired the lever can be extended, as shown in the dotted lines at *a*, so as to be convenient for easing the valves.

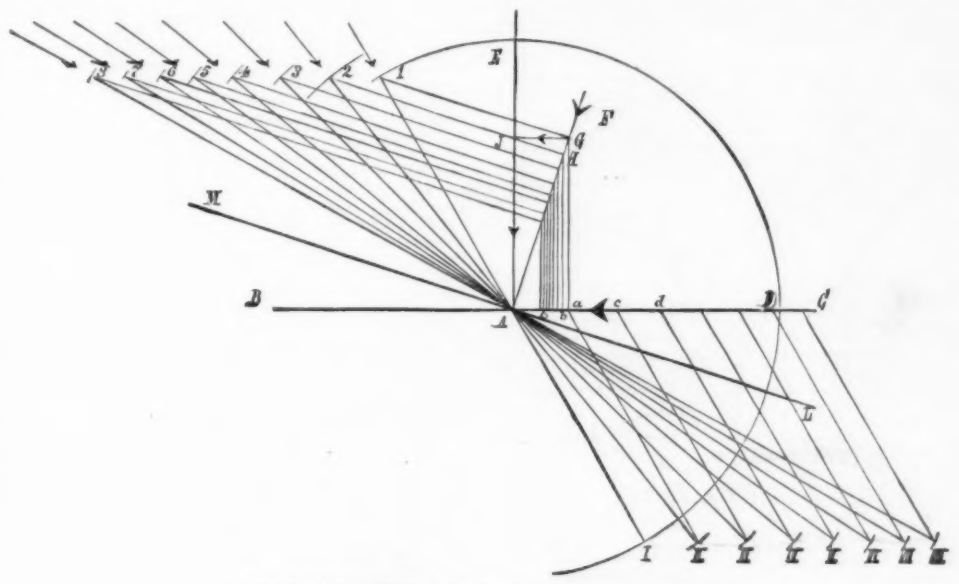
The amount of compression of the springs and consequently the load on the valves can be adjusted by means of the washer beneath the collar on the fulcrum standard; but when once so adjusted the load cannot be increased without taking the whole arrangement to pieces, and it is thus little liable to be tampered with. The whole arrangement is exceedingly neat and simple, and its performance in practice is highly satisfactory.—*Engineering.*

ICE-BOAT SAILING FASTER THAN THE WIND.

To the Editor of the Scientific American:

THE annexed diagram offers, it is believed, a new graphic demonstration of the fact that an ice-boat is theoretically able to sail faster than the wind whereby she is impelled in all cases save when the wind is directly astern. The problem owing to the method used, and to a desire on the writer's part merely to indicate the steps without following the details with great minuteness, is necessarily here but imperfectly solved and its mathematical consideration, which a moment's examination will show involves but the solution of a few right angled and oblique triangles trigonometrically, is altogether omitted. For the purposes of demonstration it is assumed (1) that friction is nil; (2) that the angle of the line, M L, which represents the sail, is relatively to the line B C, which indicates the direction of motion, such that the sail is hauled flat aft; (3) that at the commencement of movement and thereafter, there is a steady breeze in the direction 1 A, of a force and velocity represented by the length of the line 1 A. (4) That all forces are applied at a centre of effort A, located at the intersection of the lines B C and M L. A E is perpendicular to B C, F A to M L. Of course, a wind to exercise a maximum effect upon the sail in its present position should travel along the line F A, perpendicular thereto.

On the principle of the parallelogram of forces, the force of the wind, 1 A, may be resolved, and by dropping a perpendicular to the line F A, it will be seen that G A represents the component of the force which acts advantageously upon the sail. We may now resolve G A with reference to the direction of motion, B C, whence from the parallelogram, G J A *a*, we shall have the line A *a*, as the representative of that portion of the force, G A, devoted to driving the vessel ahead, and the same line will represent the velocity and space passed over in the first unit of time. During this interval a flag at the vessel's mast-head (for example), would be subjected to two forces, viz., that of the wind in the direction 1 A, and the resistance of the air, proportional to the speed, and therefore represented in direction by A *a*. Hence the flag would stream in the direction of the resultant of the two forces, or in other words, the wind would seem to have forged ahead. The new direction of the wind we may find by making A I equal A 1, and drawing the parallelogram A *a* I II, the diagonal of which A II laid off to A 2, will represent the new force and direction of the wind.



ICE BOAT SAILING FASTER THAN THE WIND.

From A 2 a perpendicular, 2 H, may as before be dropped on A F, and the force A H, being resolved, yields A *b* smaller than A *a*, as the component which urges the vessel ahead, and which likewise represents velocity, etc., for the second unit of time. Now as a body moving under the action of a constant force is uniformly accelerated, A *b* is laid off from *a* to *c*, so that the line, A C, represents the velocity at the end of the second unit of time. Proceeding as before to complete the parallelogram, A *c* I III, we shall have the diagonal, A III, or A 3, to represent the direction of the wind due to this velocity. From A 3 again a perpendicular is dropped, and the operations already described repeated until we reach, say a velocity A D, with an apparent corresponding wind A 7. It will be observed, however, that A D is less than A 1. Now starting from A D, and going through the round of operations already described, the component of A 1, devoted to pushing the vessel ahead, becomes A *o*. We set off this distance, A *o*, from D to C, proceed as before, and we have the apparent direction, A 8, and a component slightly less than A *o*; but this component, as may be seen by inspection, represents but little less than half the original useful force, A *a*, obtained from the wind in the first unit of time, while the corresponding velocity, A C, is greater than that of the wind indicated by A 1.

Other conclusions may be drawn from the diagram which it is not deemed necessary here to recapitutate. In practice, ice-boat experts say the sheet must always be kept flat aft, regardless of the direction of the wind. This accords with the diagram which indicates that the sail must eventually come to that position as the accession of velocity causes the wind apparently to draw ahead. No data giving the coefficient of friction between iron and ice is known, but taking the lowest coefficient quoted by numerous authorities, (from experiments on beach wood and oak, tallowed), namely, .05 of the weight, it will be seen that the accelerating force driving the vessel faster than the wind, is sufficient to overcome even this amount, which is necessarily very much greater than the coefficient between ice and iron. The above demonstration, it should be understood, is offered in the form of a suggestion, and is therefore presented not as an assertion of fact, but as a subject for criticism. B.

SINCE the failure of the swinging saloon of the "Bessemer" steamship, her saloon has been taken out, the midweight removed, and each end of the deck and hull has been built up, so that it is now in the shape and rig of a two-decked steamer, with a light draft. The trial trip will shortly be made on the Humber. It is expected that her full speed will be 17 knots an hour, and as a sea-going steamer she is calculated to accommodate a large passenger traffic.

NOVEL REVOLVING FIRE-GRATE.

THE great secret of economy in fuel is the consumption of smoke by feeding into the front of a furnace, so that the

FIG. 1.

products of combustion shall as much as possible be utilized in the production of heat by passing over the glowing fuel at the back. The application of this principle to household fires has not, however, been found so easy as in the case of furnaces. R. Barber, Islington, Eng., by making the grate circular and revolving, has apparently solved a difficult problem in what now seems a very simple manner. The new grate is claimed to consume nearly the whole of the smoke, and in that way, and by regulating combustion, to effect a saving in fuel of more than 50 per cent.

In the accompanying engraving, Fig. 1 represents the working portion of the grate; Fig. 2, a sectional side view of the same; and Fig. 3, the apparatus as fitted to an ordinary drawing-room stove. As will be seen in Fig. 1, the arrangement consists of a cylindrical cage or grating, A A, closed at both ends, in the centre of which is a hollow cylinder of smaller size; the whole revolving on a bar or axis, which passes through its entire length, and the ends of which

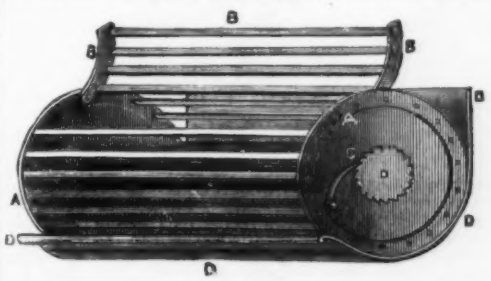


FIG. 2.

rest in sockets in the masonry or ironwork at each side. The cage, A A, is divided into segments or sections, each of which is alternately brought to the top by the revolution of the grate, and can then be opened (as shown at B) for the purpose of supplying fuel, or of placing kettles or saucepans upon the fire. The pawl and rachet, C, prevents the grate from turning the reverse way, and the guard or shield, D D, passing beneath and behind the grate prevents any upward draught.

In Fig. 2, which is a sectional side-view of the contrivance, the central cylinder, A, and the axis upon which the whole revolves are more clearly seen, as well as the guard, E E, and the open section of grate bars, B. When the fire is replenished, the coals are placed at the back of the central cylinder, at C, and as the grate is made to revolve, they gradually come forward to a position immediately beneath those which are already burning, so that the fire, D, is fed from below instead of above, as is usual, and thus the most complete combustion is secured, and very little smoke is created.

The avoidance of the usual upright draught of air has the

effect of throwing almost the whole of the heat out at the front of the grate, and also of preventing the fire from spreading amongst the coals below and behind the central cylinder. The combustion is so gradual that the grate, once filled, does not require to be replenished for twelve or fourteen hours, the fire burning clearly for the whole of that time with much less attention than is the case with an ordinary grate, all that is necessary being an occasional applica

tion of the lever by which the grate is made to revolve, so that, as the live coals become exhausted, those which are not yet ignited may be brought forward to supply their places.

The cost of construction is about the same as that of an ordinary grate, and, with some very slight modifications, the principle can be applied with equal advantages to cooking ranges, as well as to the various descriptions of furnaces.—*Iron.*

HOW NEEDLES ARE MADE.

Needle-making is an important branch of industrial art, and it has of late years attained extraordinary perfection. Small bars of steel, not thicker than a good-sized bristle, can be made perfectly round, pointed at one end with wonderful accuracy, pierced at the other end with an oval hole, the sides of which are so smoothly rounded that there is no friction upon the thread, and the whole of each instrument, not more than an inch in length, beautifully polished, and sold at less than a shilling per hundred, notwithstanding that a large part of the operations required in their manufacture are manual. The first operation, after the wire has been selected, and its thickness accurately gauged, is to cut it into eight-feet lengths; this is done by winding it in a coil of 16 feet circumference, and then cutting this coil into exact halves with powerful cutting shears. The coiling of the wire is so managed, that there are 100 pieces in each half when cut; the bundles of 100 wires are again cut into the necessary lengths for two needles; and so well arranged are the cutting shears, that a man can easily cut enough for 2,000,000 needles in a day of 12 hours. The pieces cut from a coil, although now reduced to the length of two small needles, are nevertheless somewhat curved; they are therefore collected into bundles of about 6,000, and placed in two iron rings which held them loosely together; they are then slightly softened by firing, and are laid on an iron plate or bench, and

Fig. 1

Fig. 2

Fig. 3.

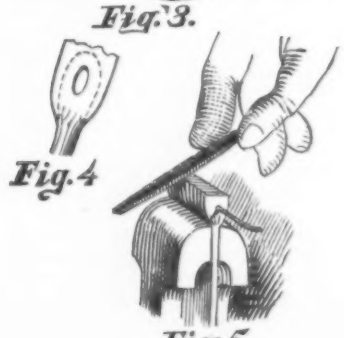


Fig. 4

Fig. 5

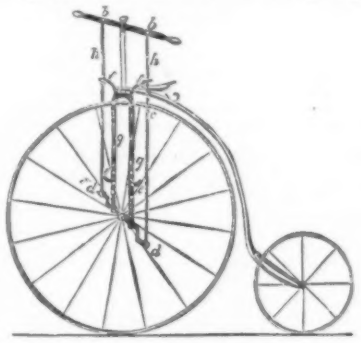
are pressed with a small curved bar (Fig. 1) in two or three positions, by which the operator manages to make them all perfectly straight. They are now taken to the grinder, who sits in front of his grindstone upon a seat which is hollow, and forms an air-shaft open towards the stone; through this a blast of air is forced when the wheel is in motion, which carries away from the grinder every particle of the subtle dust from the needle points and the stone. Before this humane invention, which has rendered the operation quite innocuous, the loss of life in this manufacture was more severe than in any other industrial occupation. The operator, with great tact, holds about 25 of the wires by means of his thumb, pressed against the inside of his fingers, the wires, which are held straight and applied to the grindstone, being dexterously turned round on the inside of the hand by means of the thumb, until they are ground sharp at one end; they are then reversed, and the other ends are similarly sharpened. They are next taken to the impressing machine, which in principle consists of weight hanging to a block, which is raised by the hand and let fall at pleasure; the wires are placed in succession under this, so that the falling weight strikes each wire exactly in the middle and there flattens it, as in Fig. 2. The hardening of the flattened part by the blow is removed in the annealing oven, and the holes are next punched, two in each flattened portion, as in Fig. 3. These are either done by hand-punches worked by children, who acquire great nicety in the operation, or by a machine on the same principle as the impressing machine; this not only punches the two holes, but also forms a small cross-cut between them (as seen in Fig. 3), which is otherwise made by a file. At this cross-cut the wire is broken in two, and may now be regarded as two rudely-formed needles, each having a flattened and pierced head, as shown in Fig. 4. A number of these are now threaded (spitted) on a thin wire, and are placed in a vice, which holds them firm and straight, so that the workman can file the heads on the top and sides, so as to remove all the burred edges, as in Fig. 5. The next process is oil tempering, for which they are made hot, and immersed in sufficient oil to coat them thoroughly; the oil is then burned off, an operation which renders the needles brittle. They are then weighed out into lots of about 500,000 each, and after being shaken so that they lie side by side, they are laid on a square piece of strong canvas, and a quantity of sand and emery powder being mixed with them,

Fig. 6.

they are corded up very securely into a long roll (Fig. 6), from 18 inches to 2 feet in length. A number of these rolls or bundles are placed on a moveable wooden slab, in the scouring machine, and over them is placed another heavily weighted slab. The action of the machine, of which those slabs form part, is to move them backwards and forwards in opposite directions, the bundles of needles acting as rollers, the pressure upon which works the enclosed needles, sand, etc., together, so that after eight or ten hours, which this operation occupies, instead of the blackened appearance they had when it commenced, they are white and silvery-looking. They are now removed to an exactly similar machine, where they are polished. Here they are separated from the sand and emery, and are removed to other canvas squares; and when mixed up with a paste of putty-powder and oil, are again corded up, and made to run backwards and forwards under the weighted wooden slab of the polishing machine for four hours more. The next process is to remove them from the canvas, and agitate them in a vessel with soft-soap and water, to remove the oil and putty-powder, and next to dry them in ash-wood sawdust. They are now highly polished and well tempered, but not all of exactly the same length, nor are the eyes perfect; they are therefore passed to a person who, by nice management of a small gauge, sorts them very quickly into certain lengths (evening), and arranges them all in one direction (heading). They then pass on to be drilled, an operation requiring great nicety, as the small oval holes have to be so polished all round, as not to cause any friction on the thread in sewing with them; a clever workman will drill and polish the holes of 70,000 needles per week. The needles are now practically finished, but many minor operations are considered necessary to produce high-finish; these we purposely omit, to avoid complicating our description. It is, however, worthy of remark, that this little instrument, which costs so much labor for its formation, has by these operations acquired immense value. The wire of which the ordinary-sized needles are made is so thin that 5½ pounds go to form 74,000 needles. Of ordinary sized needles, 2½ millions weigh 3 cwt.; and are worth rather more than £200, although the steel wire of which they were made was only worth £14 at the commencement of the manufacture. Needles are chiefly made in Redditch, Eng., and the neighborhood, where, and in other parts of the county of Worcester, this manufacture employs a large number of persons.

LARGE WHEELED BICYCLE.

THE following sketch shows a plan for bicycle by which driving wheels of any desired dimensions may be used, while the steering arrangement is the same as in the ordinary machine; it is to be driven by hand power, the guiding bar working up and down on a central bolt, giving motion



to the crank on the axle by means of the two levers *h h*, having knee joints at *c c*, and suitable joints at *b* and *d*—there are two stays at *f* to steady the levers above the knee joints. C C are moveable foot rests that can be fitted into holes in the sides of the fork *g*, to suit any length of leg.—*English Mechanic.*

ALABAMA MINERAL DEPOSITS.

In a recent letter to the *American Manufacturer*, Professor W. K. Dean speaks of Jones' Valley and the rich deposits of fossiliferous ore beneath which are the coal veins of the Black Warrior and Cahawba, elevated above water level, and their outcrops exposed along the mountain sides and railroad cuttings. The traveller as he approaches from the south enters the valley by a gap, where reposes the young but vigorous little city of Birmingham, destined at some day, not far in the future, to rival her English namesake, in the interest of her manufactures, if not in extent and variety. Jones' Valley, for so it is named, is evidently a valley of elevation; formed by the upheaval of the underlying silurian limestones. The mountain region of North Alabama is in a manner isolated from the main Allegheny range, of which it forms a part. The upheaval of Cumberland range broke the continuity of the Appalachian chain in their easterly course below the Tennessee line, thus forming the isolated hills that encircle the valley, in which the future seat of the iron industry of the south is situated.

METALLIC MINERALS—THEIR PRODUCTION AND USES.

A public meeting in connection with the Colchester, Eng., Science and Art Classes was lately held, when the following interesting lecture was delivered by Mr. J. Yelloly Watson, F. G. S.:

Mr. Mayor, ladies and gentlemen and students:—In whatever business or occupation of life you may engage, or may be at present engaged in, the use and adaptation of metals must of necessity come constantly and prominently before you. When, therefore, I had the honor of being invited to address you this evening, it struck me that a few remarks on the mineral wealth of our own country—showing how it was first discovered, and how a few of the principal metals are obtained and utilized for manufactures and commerce, might be, as I hope they will prove, both interesting and instructive to you. To enter fully into such a subject, in all its various details, would be beyond my powers this evening, or your patience. And even its salient points must be condensed as much as possible.

An old writer once said that the discovery of iron was the dawn of civilization; for without it we could neither have tools to work with nor could the arts and sciences be carried on. And in the present day metallic substances form the basis and enter into the composition of nearly all of our useful and artistic manufactures and designs; just as the crude ores from which they are obtained formed the basis as well as the chief articles of commerce noticed in the earliest history of our country.

ANCIENT USES OF METALS.

The use of metals was known in very ancient times. Tubal Cain, the son of Lamech, we are told, was the first artificer in brass, which, in those days must have been copper; for brass as we know it is a mixture of copper and zinc, zinc was not discovered till the sixteenth century. Moses wrote of "the gold, the silver, the brass, the iron, the tin, and the lead;" but it was not till about 500 years before the Christian era that metals became an article of commerce in our own country. For centuries before that time the inhabitants of Cornwall had used brushwood and turf as fuel, and in digging for peat they found tinstone, of the properties of which they knew nothing, and as they left it exposed, successive floods washed it from the different veins into brooks and rivers, where valuable deposits accumulated, and were found by the Phœnicians when they landed on the coast, more than 2,300 years ago. The Phœnicians knew the value of this tin, they collected it from the Moors, traced it to the veins, and opened up a commerce which soon extended over the greater part of the whole world.

But even the Phœnicians, long after mining operations had been established among them, do not appear to have understood the value of the ore of copper, and when they found a vein of it they passed it by; and if was not until 1691 that copper discovered in tin mines was regularly worked in Cornwall; and a charter in that year was granted to Sir Joseph Hearn, and other merchants of London for purifying and refining copper. In 1717 money was first coined from English copper. In 1762 the first brass works in the kingdom were established at Bristol, previous to which time, our copper tea-kettles were imported in large quantities from Holland.

To show you the vast importance of our mineral productions to the arts, manufactures and commerce of the country, I may mention here that the *annual* produce of the United Kingdom exceeds in value *sixty millions sterling*. The last Government return made up, which is for the year 1874, gives the total production for that year, including coal and earthy minerals, at £67,834,313. To produce this enormous amount of mineral every year, requires not only a vast expenditure of capital in machinery and labor, but the greatest engineering energy and skill; and I will now proceed to show you, as briefly and plainly as I can, how it is done:

METALLIC VEINS—WHAT THEY ARE.

Metallic veins may be described as cracks in a rock, and in these irregular cracks and crevices Nature has deposited her mineral wealth, not, however, by itself, but mixed up with different kinds of earthy matter, according to the nature of the rocks in which it is found. This is called ore. The average production of tin ore is little more than 2 per cent. of tin; copper, 5 per cent.; lead, up to 80 per cent.; so that to get two tons of black tin 100 tons of stone have to be stamped to powder, and then burnt to free it from sulphur and arsenic before it is sold to the smelter, who reduces it to the white tin of commerce; 100 tons of average English copper ore may yield five tons of copper, and the ore, after being cleaned and dressed by hand, is sent to Swansea to be smelted into ingots and bars, because it is cheaper to send it to the coals than to bring the coals to the copper.

How the mineral got into the crevices of the rock has long been a disputed question. Some say from fire or great central heat; others, from water; and there are many circumstances known to us in the present day, but which were not known to the ancients, to favor the water theory.

METALS DISSOLVED IN WATER.

Most of the water pumped from the metallic veins contain mineral in solution. I have myself put the blade of my knife into water as it was pumped, clear as crystal, from a mine, and in a few minutes it has been the color of gold from the copper deposited upon it; and at the present time many hundred tons of copper are obtained by pumping water into tanks filled with old scrap iron; the copper leaves the water, settles upon the iron, and forms copper precipitate, which sells at £10 or £20 per ton, while the old iron costs about £2 10s. per ton. The explanation of this is, that the water contains sulphate of copper—that is, copper in combination with sulphuric acid, and the acid having a greater affinity for the iron is attracted by that metal, and deposits the copper upon it. Again, in regard to the water theory, all the best mineral veins are found in the immediate vicinity of veins of clay, which cross and intersect them; and in relation to this part of my subject, I will mention a circumstance I once heard Mr. Nasmyth, the inventor of the steam hammer, relate at a meeting of the Geological Society of London, many years ago. He remarked, that if you poured hot molten iron from the furnace into an iron cauldron, the latter would be melted by the great heat; but if you line the inside of the cauldron with a coating of clay, and then pour in the hot liquid, you may put your hands outside the cauldron, and not feel inconvenienced by the heat. Thus clay, you see, is a great non-conductor of heat. When I heard this illustration from Mr. Nasmyth, it struck me very forcibly in regard to the water and electrical theory of the formation of mineral veins, which is that strong currents of electricity pass through them all, and that the clay-cross veins, against which the mineral is found, stop these electrical currents, and the mineral held in solution by the water, is condensed and disseminated through the cracks and crev-

ices of the surrounding rocks. This theory of electricity might also explain in some measure the effect of the divining rod, by which, in ancient times, the professional "dowsers" found out mineral veins and streams of water.

THE UNCERTAINTY OF THE COURSE OF MINERAL VEINS.

In olden time the saying in reference to a mineral vein was this: "Where 'tis, there 'tis;" and this sort of hap-hazard search led to much useless expenditure and loss. And although at the present day science, and a better knowledge of geology, have done much to improve the art of mining, mineral veins may still be described as among the most erratic and uncertain things *under* the face of the earth. They seem to be governed by no certain or defined laws, and to take no certain or regular course, either of direction or affinity. As an instance, I remember, more than 30 years ago, there was a copper mine in Cornwall found in a huge basin of granite, surrounded by an undercrust of killas, or hard clay slate. Out of the basin or bed of granite copper to the value of more than half a million sterling was obtained, but whenever the vein touched the slate it split up and became valueless. The richest parts were found at a short distance from the junction of the two rocks. This naturally led miners in those days to suppose that copper could only be found in granite, and they neglected other rocks. Yet, a few years afterwards, an equally rich mine was found 40 miles off, wholly in clay slate, and here it was rather extraordinary to find, the vein became impoverished wherever it touched the granite. And I could, if time permitted, give you some very extraordinary instances of the vagaries and uncertain character of mineral veins.

There is one thing, however, which has been reduced to a certainty, and that is, that no profitable metallic vein has ever been found in primitive granite or moorstone, such as we find on high hills in mining districts; though at the sides of these hills, where a softer granite prevails, minerals are found.

MINERAL LEASES AND ROYALTIES.

The appearance of some mining districts is very barren and very peculiar, and I do not think that I can describe them to you better than by giving a short extract from a small work I wrote many years ago when making a tour through Cornwall. "I am writing this," I said, "on the summit of Carn Camborne. Before me the blue sea and the 'richest' panoramic view in the world. By 'richest,' however, I do not mean in beautiful and verdant scenery, such as a novelist would describe, for between the Bristol Channel and where I sit, I see nothing as far as the eye can reach from east to west but parched and barren ground, little mountains of rubbish, and tall dark stacks of engine chimneys. I see, in fact, the richest mineral district in the world lying at my feet. I am looking upon mines from which scores of families have been enriched, and many beggared. From up these dark shafts men have come as working miners, with newly found 'mineral' in their pockets, the 'forerunners' of fortunes, which have made their descendants in some cases the largest landowners in the county, and in others men of mark, of rank, and title. And even now, as I look upon the apparently quiet scene, and watch the heavy beams of the engines work lazily up and down, thousands upon thousands of men are burrowing underground like moles, some seeking an *ignis fatuus*, others working by the light of a farthing candle the uncertain veins; and as they work enriching others if not themselves." Now, the group of mines referred to as lying at my feet as I then sat on the top of Carn Camborne had yielded minerals—chiefly copper and tin—to the value of *forty millions sterling*.

But though rugged and barren, the owners of such land as this, often reap a rich harvest without sowing and without labor or trouble. The owners of the soil, in fact, get what is called a "dish," dues or royalty upon other men's labor. They grant leases and get $\frac{1}{13}$th, $\frac{1}{14}$th, or $\frac{1}{15}$th, as the case may be, of the gross value of all the ores brought to surface by the working bees. Thus, if miners get in a year ores worth £15,000, they make it marketable, sell it, and hand over to the landowner £1,000 free from all deductions, supposing the royalty to be $\frac{1}{15}$th. In addition to this, the landlord gets at the rate of £100 per acre for all land taken for erecting engines, and depositing attle or rubbish; this is called "surface damage," and is paid for land that in many cases would not be worth 5s. per acre for any other purpose.

In our own county of Essex the rich and luxuriant soil fertilizes near the surface, and is comparatively valueless in depth. Tap the hard barren rock of a mining district and a mineral produce is found, without which our corn could neither be cut, harvested or made useful to us. Such is one of the great and compensating balances so often found in a study of the great and wonderful works of Nature. If mines had been regularly distributed over the whole earth, and near the surface, it would have been rendered unfit to produce food for cattle or grain for man.

ORIGIN OF THE FAMOUS TAVISTOCK MINES.

While on the subject of royalty and the value of mineral land, I will relate to you one or two extraordinary circumstances. Many years ago, an old miner wandering in a wood belonging to the Duke of Bedford, near Tavistock, found an outcrop of gossan (which is a mixture of oxide of iron and quartz, invariably found on the top of mineral veins), and thinking he had found a prize, he began to sink a pit upon it, but in doing this he frightened the Duke's pheasants, was ordered off the ground, and the place was neglected for years. In 1844, however, a descendant of the old miner examined the pit, and got a license from the late Duke to open it. He was joined by a few capitalists, among them two of the partners of a gentlemen who had at one time represented Colchester in Parliament, and they subscribed £1,000 among them as working capital. Well, from 1845 to the present time that pit and a line of others through the wood on the same vein have paid the Duke of Bedford £251,888 17s. 4d. in royalty or rent, a fine £20,000 for a renewal of lease, £2,052 for land destroyed, and £840 19s. 11d. for timber removed.

I was on the spot in 1846, when there was scarcely a building or a cottage in the wood. I went there again many years afterwards and found the place a little town. And from 1845 to 1872, besides the royalty and the other sums I have named as paid to the Duke of Bedford, these miners paid £1,352,310 7s. in labor; for steam engines, water wheels, timber, iron, and almost every kind of machinery, they paid £362,970 18s. 10d.; and last, though not least, they divided from the old pit in the wood among themselves as profit £1,186,816.

I was first on the property as I said, in 1846, and something then happened which in a manner illustrates my theory as to mineral veins. I will add that this great discovery of copper was near the eastern boundary of the Duke of Bedford's estate, and I joined a few friends in sinking a pit on the other side of the hedge in a neighboring property, and where, according to all human probability, we considered the vein *must* continue; *but it didn't*. We spent some thousands of pounds in the search and never got an ounce of copper in return, and the reason was only found out a few years later, when it appeared that the enormous deposit of copper ore on the Duke's land had been formed against a large cross vein of clay. The electric current, or something else, had warmed up the Duke's side, but left no such deposit on the other.

This Devonshire mine may be said to be the most extraordinary in England, as the Parys Mountain, in Anglesea, was the most extraordinary in Wales, or perhaps in the whole world.

INTERESTING HISTORY OF THE ANGLESEA MINE.

The latter apparently barren mountain belonged half to Sir Nicholas Bayley, and half to the Rev. Edward Hughes, a Welsh clergyman. The former gentleman was desirous of possessing the whole mountain, and the story goes that Mr. Hughes went up to London to negotiate with him for the sale of his half. He knocked at the great man's door, and the magnificent flunkey who opened it, treated the humbly clad old man with such disdain, that the pride of the Welshman was aroused; he turned upon his heel and went back to Wales. And lucky it was that he did so, for shortly afterwards, that is on March 2, 1768, copper ore was found near the surface of the mountain, and the place turned out to be a very mountain of copper. From one great open cutting, three-quarters of a mile long, several hundred yards wide, and about 120 yards deep, copper to the value of five millions sterling was obtained. Sir Nicholas Bailey's son was created Earl of Uxbridge, and his grandson Marquis of Anglesea; Mr. Hughes' son, who also became enormously rich, was created Lord Dinorben. I have myself made a study of this mountain of late years, and a very interesting experiment is now going on there, partly under my own direction, and that is, to tap the mountain 60 yards under the great deposit of copper. This could only be done by driving a gallery, which has been some years in progress; but what the result will be no one can tell—I wish it could.

HOW MINERAL VEINS ARE WORKED.

When an ordinary mineral vein is found it is worked by means of shafts, winzes, and galleries, or levels. The latter are driven every 60 feet that the shaft is sunk, and the winzes, or small intermediate shafts, connect the diff rent levels, to give ventilation and open out the vein, so that the mineral can be taken away in the easiest and least expensive way. Shafts, some of which are sunk to a depth of more than 1,000 feet, cost, according to the hardness of the rock, and the quantity of the timber used in casing and dividing them, from £4 up to £20 per foot; so that it is a matter of vast importance to begin them in the right place, which is not always possible. Copper and tin veins, as a rule, run east and west, and dip into the earth, like the slanting roof of a house, north and south. Lead veins run both ways and dip accordingly.

In sinking shafts and driving levels, the workmen are paid by the fathom of 6 feet, the price being calculated so as to give each man an average pay of about £4 per month. The ore between the levels or galleries is worked or taken away upon what is called a "tribute." Six men, for instance, take a portion of a vein called a "pitch," to work for a month, or other fixed time, or for so many fathoms high and so many long; and they get for themselves 10s. or more, as the case may be, in every pound's worth of ore they bring to the surface. They are allowed powder, candles and other materials, at cost price during their work, and the price of these is deducted when the ore is weighed and sold, and they receive their proportion of its value. There is a great deal of excitement and speculation in this sort of work, and many a working man, commencing as a "tributer," has ended a mine owner. When the ground is set to tributers, it is let to them at the value it then presents, and calculated so as to give them the usual monthly wages; but a single stroke of a pick, or a blast of gunpowder, has sometimes revealed fortunes, and before many days the tributor may get into a vein ten times richer than it was when he first took it, but he sticks to his "pitch" as long as it lasts, and receives his original proportion of whatever it produces. I once knew a small gang of tributers in this way make £1,200 by their pitch, when at starting they expected to get about £30.

When copper ore is raised to the surface it is chiefly dressed by hand, and at many mines two or three hundred boys and girls may be seen sitting or lolling on benches in sheds, chipping off the bits of rock or other matter from the ore, and singing merrily as they work. They throw the ore into barrows, and it is taken to a crushing mill, broken into small bits of the size of a nut, and laid out in parcels for sale.

When a farmer sells his corn, he takes a sample from the bulk and sells by it. When a miner sells his produce the buyers take the samples for themselves, which they put into crucibles, melt and assay, and according to the "produce" or percentage, so they bid for it. For instance, if a sample of ore shows a produce of 5 per cent. of copper, and the price of that ore is what is termed 15s. per unit, or one of produce, he multiplies 15s. by 5, and bids £3 15s. per ton for the ore. On a certain day, generally once a month for each district, there is a public gathering (and always a good dinner) called a "ticketting," when buyers and sellers meet, the former put in their "tickets" or bids, and the highest bidder for each lot gets it. In this way, from £50,000 to £100,000 worth of ores have been frequently sold in a day. The ores are then shipped to Swansea to be smelted into ingots, etc.

USES OF COPPER.

The uses of copper, as copper, are various and important, as you all know. In combination with one-third zinc, it becomes brass; with tin it forms bell-metal and bronze; with acetic acid, verdigris; and with sulphur, blue vitroil.

TIN ORES AND USES OF TIN.

Tinstone, which is raised much in the same way as copper, has to be stamped to a fine powder. The stamp heads which are heavily laden with iron, pound away in small boxes, having in front a copper grating almost as fine as muslin; a continuous stream of water is then let in at the back of the box, and the stone, as fast as it is crushed into powder, is forced through the grating into pits prepared for it, and the tin being the heaviest, settles at the bottom, while the *debris* is washed away as slime, to be re-dressed at another opportunity. After this, the powdered tin has to be burnt in horizontal chimneys to get rid of arsenic and sulphur, the dressing of tin, therefore, is a very expensive process, and it is calculated that to raise it from the earth, dress and prepare it for the market, costs from £40 to £50 per ton; it is then sold to the smelters, who make it into the white tin of commerce. Prior to 1838 all the tin raised in Cornwall paid a duty of 4s. per cwt. to the Duke of Cornwall, and in this way George IV., when Prince of Wales, received as much sometimes as £30,000 in a year.

Tin ore is generally found in secondary granite, or in very quartzose or micacious clay slate, and goes down to a great depth. The deepest tin mine of the day (and it has been worked now for 100 years) has a shaft down about *seven hundred yards* from the surface, and the cost of working it is in labor alone nearly £30,000 a year. Many years ago the men were nearly exhausted in getting to and from their work by descending and ascending ladders for such a tremendous depth, but now they have "man engines," like the lifts you see in tall buildings, which take them down and bring them up at stated times, stopping on their way at every level of 60 feet.

Tin has various uses. I need not describe to you how useful it is for pots, kettles and pans; but I may tell you that many hundreds of tons are used annually for dyeing purposes. This particular tin is "granulated" in its manufacture, and it indelibly fixes the colors in silks and satins.

LEAD ORES AND USES OF LEAD.

Lead mines are chiefly found in the limestone formation, and are worked in the same way as tin and copper. The veins, when not of pure galena, are intermixed very freely with "blende," or one of the ores of zinc, which has to be separated from it in dressing.

Galena, or the commonest of lead ores, averages about 80 per cent. of lead, and contains a small proportion of silver. Silver-lead ore, which is harder and more compact, has sometimes from 30 to 50 ounces of silver to the ton. In 1874 the silver extracted from lead ores in the United Kingdom was 509,277 ounces, valued at £127,319. In former times the silver was not extracted from the lead, and for this reason very old lead found on the roof of churches and old buildings is far more valuable than new, as a great deal of silver may be got from it.

Led with half its weight of tin forms *solder;* with a quarter part of antimony it forms metal for printing-type; mixed with a small quantity of arsenic it will run into drops, and from this composition shot is made. Sheets of lead rolled up and placed under vinegar become covered with *white lead*, or the ceruse used for paints; dissolve this in acetic acid and you get sugar of lead.

In all metallic mines I have thus referred to, water is very troublesome and expensive to overcome. In the Consolidated Copper Mines of Cornwall, the levels or winding galleries were 60 miles in extent, and 10 or 12 large steam engines had to be kept going day and night to pump out the water and allow the miners to work. Very few shafts can be sunk anywhere, beyond 30 or 40 yards, without steam power, an as an ordinary engine consumes about 1 ton of coal a day, the water charge is a very serious item in all underground operations.

IRON AND ITS USES.

I remarked at the commencement of my address that the discovery of iron had been described as the dawn of civilization, and marvellous are the uses to which we have seen it applied in our own times. We have seen new towns spring up, new trades and employments created, and the old habits of business, and even of ordinary life, revolutionized by the "iron horse." There are many of us here to-night who, had we been told 50 years ago of the wonders that the steam engine and the iron rail would do, not only in developing the extraordinary engineering talent of the age in the impetus they would give to every kind of labor, ingenuity and skill, in the new ideas they would give us, and the changed habits of the people they would bring about, we should have looked upon the tale as the wildest romance. But the changes that iron has produced, more wonderful than anything we could then have conceived, are in evidence around us daily, and we have ceased to regard them with wonderment, and perhaps to value them as we ought. But when we consider that iron, without which none of these wonders could have been accomplished, is the most abundant as well as the most easily obtained of all metallic minerals, we have further evidence that there is nothing that the ingenuity or talent of man can conceive or put into practice for the general welfare but he will find the materials stored up and amply provided by an all-wise and omnipotent Creator.

Iron has been wrought in this country from a very early period. It is found in all soils, disseminated through all kinds of rock, and found in quarries that are easily worked In the Forest of Dean iron was known as early as 1066, but the working of it was stopped for a time by act of Parliament in 1580, in consequence of the great consumption of timber used in smelting it. Soon after this Lord Edward Dudley invented the process of smelting with pit coal instead of charcoal. And it is a somewhat singular circumstance that in the year 1239, about 70 years after a charter had been granted to the town of Newcastle for the "digging of coal," taking it to London was forbidden, because its use interfered with the burning of wood, and was, therefore, injurious to the owners of the woods near that city, and from which it was supplied with fuel.

When smelted iron may be described as cast or pig iron, wrought or malleable iron, and steel, the latter being refined iron combined with carbon. Plumbago, or black lead, from which pencils are made, is a natural compound of iron with a large proportion of carbon. Many of our most precious stones, such as the ruby, amethyst, turquoise, garnet and cornelian, owe their beautiful colors to the oxide of iron.

I fear that I have now trespassed too long upon your patience, and will only add in conclusion, that it is close upon 40 years since I commenced to write my first book upon the subject I have brought before you this evening. Since that time I have had some little practical experience in the fascinations, the uncertainties, and the vicissitudes that attend the search for the mineral treasures of the earth; but there are a few lessons which such work teaches applicable to every pursuit, and I would commend them to the serious attention of you all. Never be disheartened by temporary failures, or unduly elated by temporary success. In whatever you undertake to do study it thoroughly, and then pursue it with an earnest and steady perseverance.

At the conclusion of the lecture, the delivery of which was several times interrupted by applause, Mr. J. B. Harvey, J. P., rose to propose a vote of thanks to the lecturer, who, he said, in addition to presenting the Colchester Museum with a very valuable collection of minerals, also wrote a very useful hand book or guide to the collection, which people would do well to have in their hands when examining the various specimens.

The lecture had been fraught with instruction, it had been delivered in a style which he was sure must have contributed very largely to the easy acquirement of knowledge, it had been a thoroughly practical lecture, and he begged to move that their hearty and cordial thanks be accorded to Mr. Watson for the treat he had given them. The motion was carried with acclamation.

LESSONS IN MECHANICAL DRAWING.

By Prof. C. W. McCORD.

Second Series.—No. 2.

REFERRING to the instruments of which we gave illustrations in our last paper:

We shall take occasion from time to time to illustrate by example the precept which we now lay down, that it is well to form the habit of using the scale before drawing the line.

Thus, if a line is to be drawn, say a foot long, many will draw first a line fourteen or fifteen inches in length, then set off the required distance, and either rub out the superabundant pencil mark at once, or, more likely, leave it till a more convenient season. At an early stage we insisted that when possible it is better to leave out a line than to rub it out; when the exact length is known it is always possible to draw it of that exact length by measuring it first, and we are now about beginning a class of work in which it is more necessary than ever to have the pencil drawing as like the ink drawing as it can be made; the first step to which is attention to this direction. We repeat, then, now that you have your scale, do not be afraid of handling it; it is perfectly harmless, and it is better to make too many measurements than too many marks.

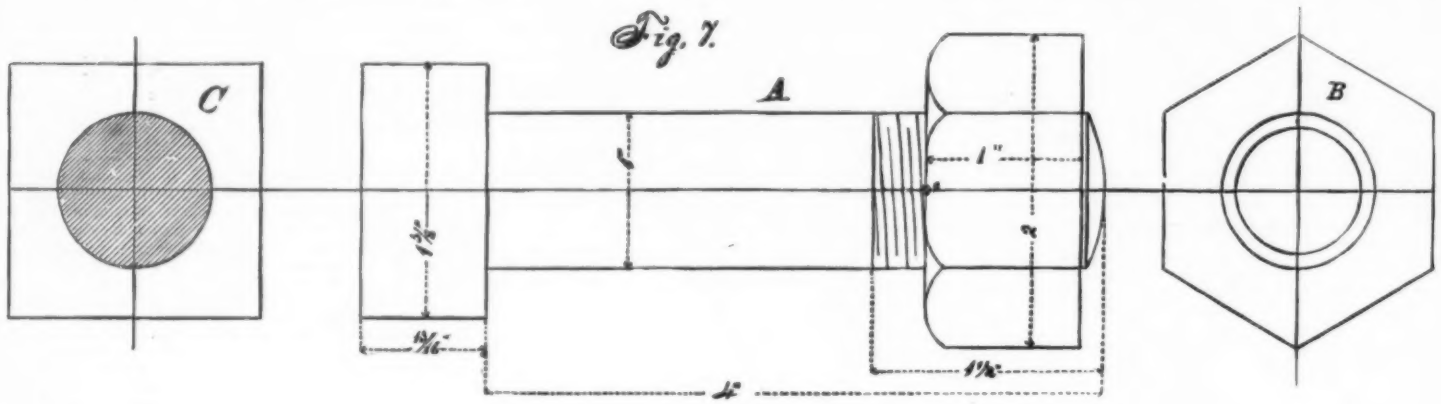
We select as the first subject, in illustration of detail drawing, a bolt and nut. This may at first sight appear ridiculously simple; and indeed it is, abstractly considered, of a very elementary nature. But there is more than one reason for considering it at some length, before going further. In the first place, the fastenings are important parts of every piece of mechanism, and it is well to settle at the outset on the best mode of representing them. And again, more radical errors are frequently made in the drawing of a bolt and nut, than in regard to any other detail of equal simplicity. We wish our readers to guard against these, and even in such elementary matters, to express their meanings clearly with the least labor.

In Fig. 7 we have shown a detail drawing of a bolt with a square head and a six-sided nut. In a machine shop, it is customary to make out a sheet of such drawings, representing the different kinds and sizes of the bolts and nuts to be used in any engine or machine which is in progress of construction. This work is usually entrusted to a beginner; let the reader then imagine himself to be such an assistant draughtsman, and endeavor to perform the task, simple as it may seem, in a creditable manner, as a step to preferment.

Now, in order to make this drawing abstractly complete we have given a top view of the nut *B*, and a section *C*, showing the form of the bolt and the head. Were these two views omitted, the head *might* be oblong instead of square, and the nut an irregular instead of a regular hexagon.

But it will readily be seen, that these two views are practically superfluous, because it is the universal custom to make the head and the nut of regular forms, unless there is an express instruction to make them otherwise. The front view *A* shows them correctly if they be made regular, and since by common consent they are held, in the absence of information to the contrary, to represent those forms and n

Fig. 7.



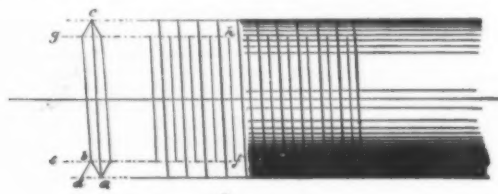


Fig. 8.

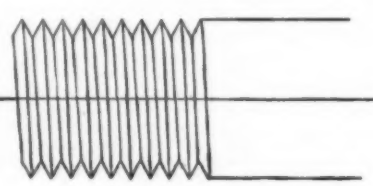


Fig. 9.

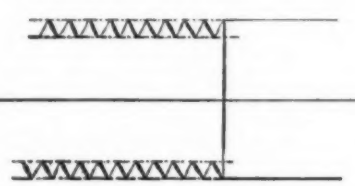


Fig. 11.

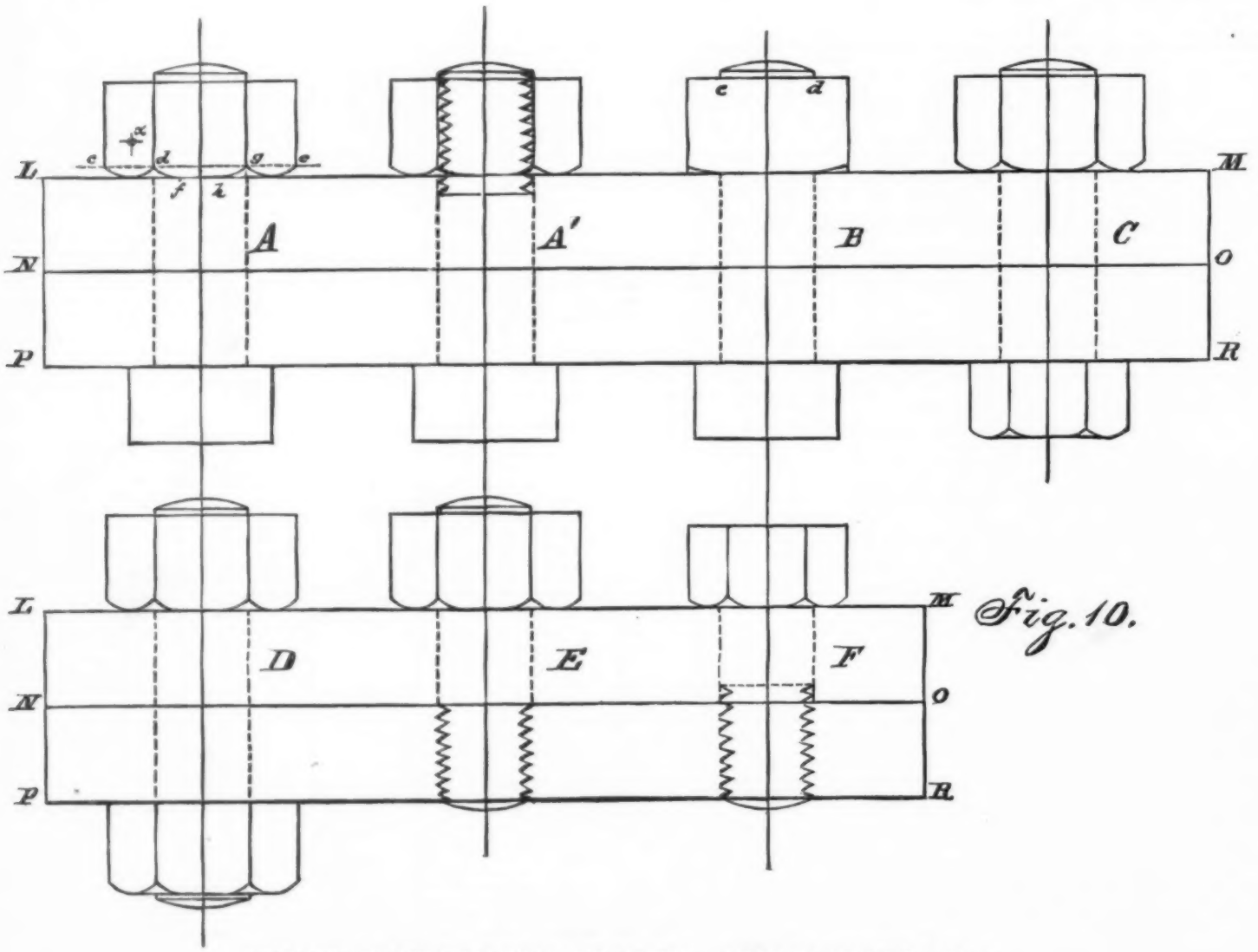


Fig. 10.

LESSONS IN MECHANICAL DRAWING. SECOND SERIES.—No. 2.

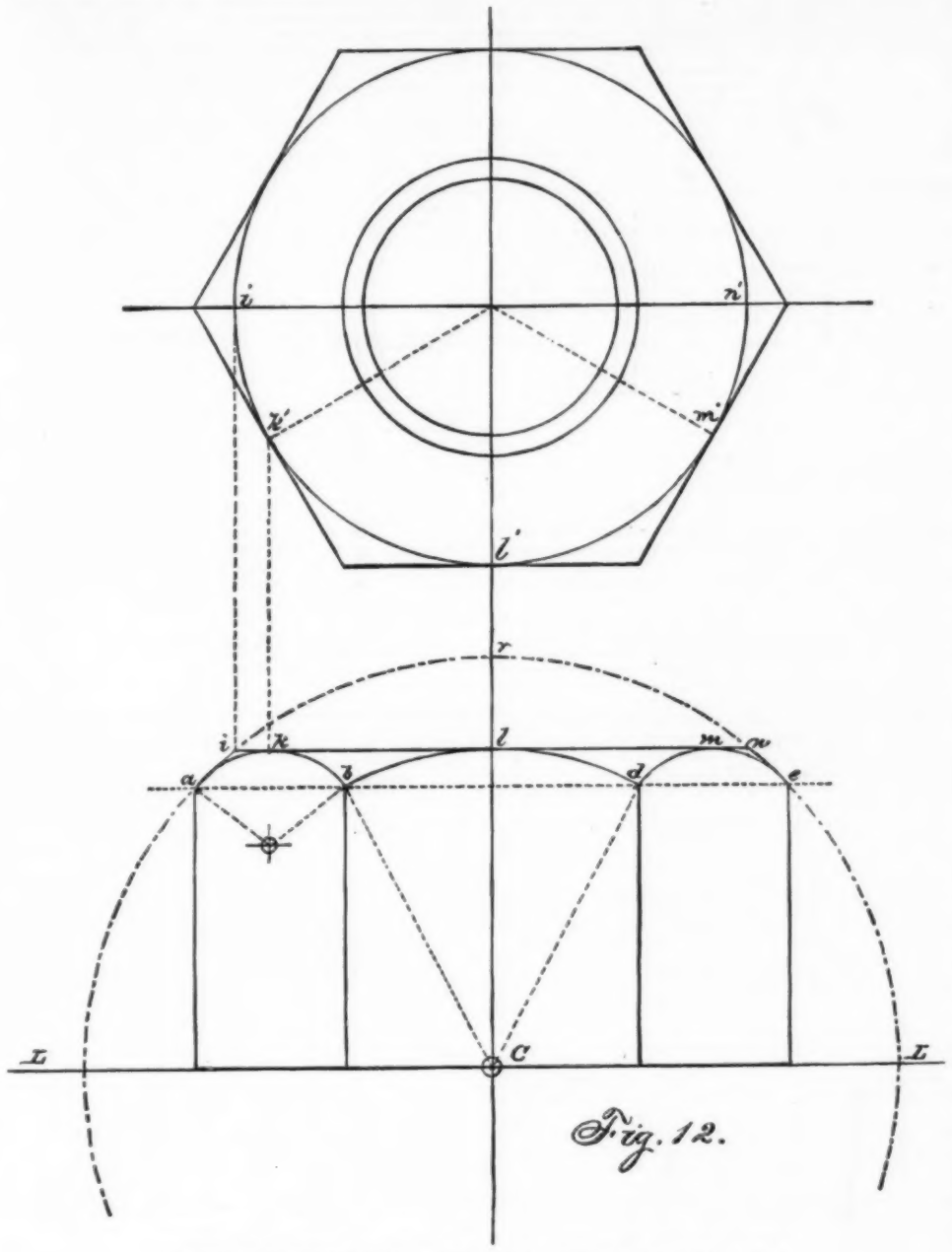


Fig. 12.

LESSONS IN MECHANICAL DRAWING. SECOND SERIES.—No. 2.

others, it is a sheer waste of time to draw more than that single view.

Next, it will be observed that the dimensions are marked, although the bolt is drawn of its actual size. On this point there is a difference of opinion; some contend that the figures ought not to be given in a full size plan, but that the workman should use his rule, and measure the drawing for himself. We must say that we can not see any great advantage in this; it is not a bad habit for the mechanic to measure the plans from which he is working, but as there may be discrepancies between his rule and the draughtsman's scale, we are inclined to hold that all the more important dimensions should be given in figures, always. And surely it can do no harm if all the figures are given, and it saves time in the shop, if they are properly put on the plan. We merely call attention to the manner in which it is done in the figure; we shall have more to say on that subject bye and bye, and in the meantime it will be observed that every dimension is is marked in a clear and conspicuous manner.

We have now something to say in regard to the manner of representing the screw-thread, which is visible below the nut; we use the word *representing* designedly, for the reader will not fail to observe that we have not made a *drawing* of it. This is a V-threaded screw, of which a full discussion, and instructions for making the accurate drawing, were given in Lesson XXV. of the first series. But it was there stated that a great many cases will be met with, in which it would be absurd to take that trouble, and this is one of them.

Were the object to show just how the thread is to be made, we would be obliged to draw the screw accurately according to the instructions referred to, enlarging it if necessary in order to exhibit clearly the form and dimensions of every part.

But this is not the object of this drawing. In every shop there is some standard or other, according to which bolts of different sizes are threaded; it is enough, then, to show that this is a 1 inch bolt, with the thread cut to a certain distance. It is not necessary to go to the trouble of drawing the screw with precision, nor even to state, ordinarily, the number of threads to the inch. Still, the drawing, to be complete, should indicate the threaded part in some way; and this may be done with all needed accuracy, as shown in the figure.

The mode of executing this is illustrated more distinctly in Fig. 8. Let us suppose that we know the number of threads to the inch, which gives the pitch *a d*. Then, in so fine a screw as we are now dealing with, we may disregard the flattening of the thread and groove; and if they be sharp, the depth is readily found by drawing a section of the thread with the 60° triangle, which enables us to draw the guiding lines, *ef*, *gh*.

The crest *c*, on the opposite side, is opposite the root, *b*, of the thread, and we should, strictly, draw a helix from *a* to *c*. But the curvature is so slight that we may merely draw a right line instead; and similarly for the root we draw the right line *bk*. Nor need we, practically, draw the section of the thread; all we want is to ascertain the inclination, which done, we set the triangles, and represent the screw simply by a series of parallels, terminating alternately in the extreme outlines, to show the tops, and in the inner guiding lines, to show the bottoms of the threads. The former should be drawn heavier than the latter, because the crests or tops of the threads cast shadows.

Now we know that this is a purely conventional way of indicating the screw; it is not at all a *drawing* of it, in a strict sense, but it serves the purpose, for it does indicate it just as well as the most elaborate drawing would, and at a little distance it looks like one too, whether it is like it or not. In fact it looks a great deal more like one, on a small scale, than a correct drawing would be likely to, or even one in which, as in Fig. 9, the V form of the thread is shown, the helices being drawn at right lines.

This is the next step, and this mode may be adopted for screws of moderate size and fine pitch; but if they be small, the attempt will be a failure unless the most painful precision be attained, so that it is never worth while to make it.

Nor is it worth while, in making ordinary working drawings, to set out the precise pitch; a very little experience will so train the draughtsman that he can approximate closely enough to the proper depth of thread, and having thus found the inclination, the parallels are spaced by the eye alone. Finally, the *outlines* only are drawn in ink, very finely, the guiding lines at the bottom of the threads being rubbed out. We have spoken only of the *amount* of the inclination; we need only suggest that care must be taken to make the thread slope the right way, so as to indicate a right-handed screw, that is, one that enters the nut by turning to the right, like the hands of the clock, as a left-handed one is very seldom used.

In Fig. 10 are shown two pieces of metal, *L M N O*, *N O P R*, fastened together by bolts of various kinds. At *A* we have one like that given in Fig. 8. *B* has both head and nut square, *C* has them both hexagonal, and *D* is a bolt with a nut at each end. The two pieces fastened together are shown in outside view, thus concealing the bolt, which is dotted; and it will be observed that there is no indication of the screw-thread.

Nor is it necessary. The object being to show the form and size of the bolt, it is assumed that any one who knows what a bolt is, knows that it has a thread cut on it a little further than the depth of the nut, so that it may "draw;" if he does not know so much, it is not likely that he would know what the thread was if it were drawn in, as it is at A^1, and it will be seen that the appearance of the whole is not as clear as when it is omitted.

E is what is called a "standing bolt," or stud. The lower piece *N R* is tapped, and the lower end of the bolt being threaded, is screwed into it until the thread "bottoms," thus jamming itself tightly into the surface; the object being to make the bolt stay there, so that it will not come out when the nut is unscrewed. The thread is therefore shown as terminating sharply at the line *N O*.

F is a "tap-bolt," the lower piece *N R* is also tapped, but the bolt is threaded so far that when screwed down by its head, the thread will *not* bottom, but merely draw *M N* and *N R* together. This is also indicated by drawing in the thread, its termination being made conspicuous by drawing a dotted line across the bolt.

Now, as to the manner of representing these threads. It is done, it will be observed, just as though the screw were drawn in section; because this is at once the simplest and the clearest way in which the peculiarities of the bolt can be shown. And the manner of doing it is shown in Fig. 11; the guiding lines for the top and bottom of the thread being drawn in pencil, the thread is drawn by the free hand with a common fine-pointed steel pen; a light up-stroke or hair line is followed by a heavy down-stroke, which produces the effect of a shadow line.

It is wholly useless, except in finely-finished drawings, to take the trouble of using the triangle and the drawing-pen; a little practice will enable the student to draw the threads as above explained with all needed precision; but care must be taken to lift the pen entirely off the paper at each stroke; for the attempt to make a continuous line, as in writing, will be sure to result only in a sinuous curve, and the good effect here depends on the sharpness of the angles. It is not of the least consequence whether the heavy strokes are really on the upper or the lower side of the thread, so that these things may be drawn from whichever side happens to be the more convenient.

It will be noticed that the standing-bolt *E*, and tap-bolt *F*, Fig. 10, are shown as rounded off at the bottom; the radius is not material, but may be say equal to the diameter of the bolt; and this curve should be, as shown, the only thing that projects beyond the piece into which the bolt is screwed. Any prolongation of the bolt would be useless, and unsightly as well; and in a drawing as much care should be taken as in the machine itself, to make everything look workmanlike. The tops of the bolt are rounded off in the same

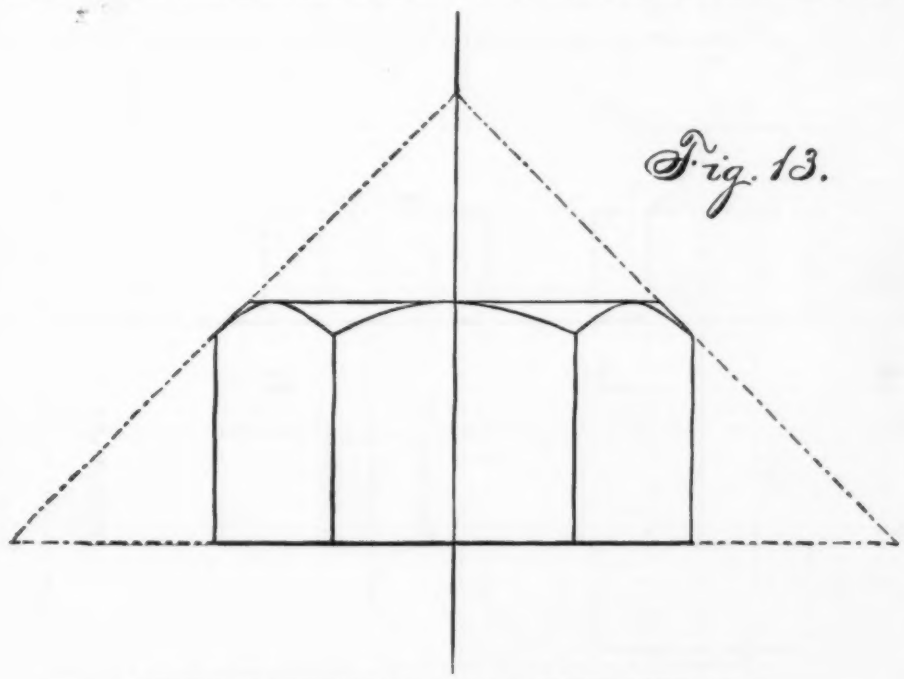


Fig. 13.

LESSONS IN MECHANICAL DRAWING. SECOND SERIES.—No. 2.

way, the center of the arc in each case being the middle point of the lower side of the nut, as *C*, Fig. 7.

But in this case the bolt is allowed to project a little beyond the top of the nut; not more, however, than the pitch of the thread. This is because there may be minute variations in the thickness of the flanges or other pieces bolted, as well as in the depth of the nuts; and also because it really looks better than it would to have the bolt just flush with the nut. In the drawing, all that is necessary is to make a line "square across," without regarding the inclination of the screw thread, and then draw the arc.

It will also be observed that in each case the nut has its lower corners, when it bears on the piece *MN*, rounded off. The reason for this is, that the nut must be turned round in order to screw it down; if, then, the corners were left sharp, like those of the head of the bolt *C*, the sharp edges would catch upon any little inequalities which might exist on the surface in contact with it; and if that happens, we may exert considerable pressure on the wrench, and think we are screwing the joint up very tight, when really it is quite slack. This is avoided by rounding off the corners of the nut, *on the bearing side;* and the drawing ought always to be made so, notwithstanding the fact that probably seven draughtsmen out of ten round off the upper corners instead, on the ground that it looks better to them. On this point we make bold to dissent, for we have seen a great deal of very fine machinery put together as we have shown it, and to our taste it looked well. But whether or no, it is radically wrong to put on a nut with sharp corners down, and if the taste of the designer cannot be satisfied unless the top corners are rounded off too, then let them be made so. In the case of the bolt with a nut at each end, at *D*, the lower one may properly have the sharp corners next the flange, since it is not expected to turn round, and indeed it would be if anything better that it could not; it is, in point of fact, really the head of the bolt, and the other one is the nut proper. In like manner the lower corners of the hexagonal head of the tap-bolt *F*, are rounded off.

In the case of the 1-inch bolt, Fig. 7, it will be observed that the nut measures two inches "across the corners," and one inch in depth. Now we may say here, that this is not precisely according to either the English or the American standard. We may hereafter take occasion to give the proportions according to those standards, for the heads and nuts of bolts of various sizes. Meanwhile these are made slightly different, for the purpose of calling attention to the fact that much time may be saved on a drawing in which the bolts appear incidentally, by making the depth of the hexagonal nut equal to the diameter of the bolt, and the "long diameter," or distance across the corners, just twice as great. Not only is so simple a rule easily remembered, but the setting out with the scale is facilitated, since we have only to lay off, on each side of the center line, the radius and the diameter of the bolt; and, finally, the front edges of the nut being in line with the sides of the bolt, we do not have to shift the triangle in either inking or pencilling.

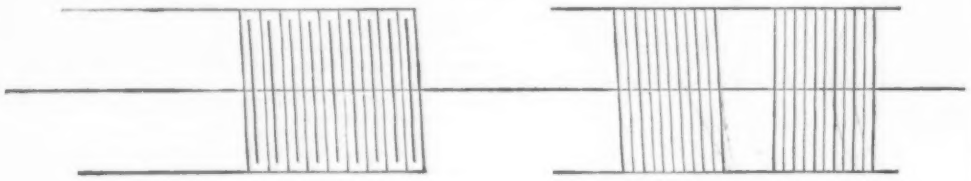


Fig. 14. Fig. 15.

LESSONS IN MECHANICAL DRAWING. SECOND SERIES.—No. 2.

We propose now to make a study of this nut, in reference to the appearance which should be presented by the corners when they are rounded off, upon which some lay great stress. Or, the head of the tap-bolt *F*, will do as well, being of the same form; if it were in the lathe, it would be natural to turn off the corners, and the question then is how they would look if it were done. This brings us back to a problem of the intersection of a surface, which can be formed in the lathe, by a plane parallel to its axis. In Fig. 12, *AB* is the axis of the hexagonal prism, and *C* the center of a sphere, of which the outline is dotted. The edges of the prism evidently pierce this sphere in the points *a, b, d, e,* all of which are at the same height above the horizontal center line *LL*. And the front, or nearest, plane face of the prism cuts the sphere in a circle, whose radius is *Cb*, with which we describe the arc *b l d*. But the sloping faces of the prism also cut circles from the sphere, of the same size, because they are at the same distance from the axis; these will appear in the figure foreshortened into the elliptical arcs, *a k b, d m e,* and *k l m*, will be a horizontal line tangent to these three curves, at their middle or highest points. If, then, we had the prism in the lathe, and turned off the end into the segment *a r e*, of the sphere, with radius *Ca*, we see what the result would be. If we now go one step further, and cut the segment across by the plane *i l m*, perpendicular to the axis, the section thus made will be a circle, seen in the top view, whose radius is *i l*. The front view of what is left will then be as shown in full outlines, and manifestly of a proper form for a nut. And there are those who go so far as to insist that the nut always ought to be drawn so. We admit that in highly elaborate drawings, of the nature of pictures, there is no objection to it, but in an ordinary working drawing there is an objection, on the score of the time it takes. To be sure, the elliptical arcs, *a k b* and *d m e*, differ so little from circular ones, that they may be drawn as such, but we must use a different radius for the other arc, *b l d*; and then, the little spaces, *a i k, m n e*, call for the use of another radius, and are so minute, if the nut or the scale be small, as to require considerable care to make them perceptible without marring the appearance of the drawing.

For all practical purposes, then, the latter may be omitted, and the drawing of the nut much simplified by making it as shown in the preceeding figures, the detail of which operation is shown in the case of the bolt *A*, Fig. 10. Draw the horizontal line *c e*, at a distance from the bottom of the nut about one-eighth of its height, cutting the front edges in *d g*, find by trial a center *x*, and a radius with which to draw the arc *c d*, tangent to *S M;* then the other arcs, *d f, g h, g e*, are drawn with the same radius. This indicates the rounding off of the corners, which is all that is wanted; the approximation to the precise appearance of Fig. 12, is close enough, and as one radius suffices for all the nuts of the same size, much time is saved. This saving of time, as we have repeatedly stated, is of the utmost importance; we do not mean to imply that we should save time at the expense of introducing or omitting anything which would lead to erroneous execution of the work; but it will be seen that we have not done so. The corners of the nut are to be rounded, which is the main thing, and the mode of indicating it recommended does not bind the workman to any definite manner of doing it. He may turn them off by a spherical finish, as in Fig. 12; or he may take a fancy to the conical style, shown in Fig. 13, the construction of which is left to the reader as an application of a previous exercise; or he may have other ideas of his own, and if he has he will be tolerably sure to adopt them, however the drawing is made, knowing very well that it makes no practical difference.

Another means of economizing time, in drawing the bolts and nuts as a part of a plan, to show the mode of fastening, and not as a special working drawing for making them, depends on the proportion between the size of the bolt and that of the nut, when the latter is of hexagonal form. And it would do no harm if these proportions were actually used for all the bolts and nuts ordinarily used as fastenings up to 1½" in diameter. The nut is a little in excess, but up to that size the difference is trifling. And in making out the special drawings for the bolts, any desired standard may be used, although the above proportions be adopted in the general plan and in the other detail drawings.

The corners of the square nut are also to be rounded off on the bearing side. This might be made the subject of a special study, as was done with the hexagonal one, if it were of sufficient importance; we do not think it so, and if the reader does, he ought by this time to be able to work it out for himself. For all ordinary purposes this is well enough indicated as at *F*, Fig. 10, two arcs being drawn, with centers *c* and *d*, the intersections of the sides of the bolt by the top line of the nut, and with a radius equal to the depth.

But we call attention particularly to one thing, which is, that in all cases we have shown the flat side of the square head or nut, and one of the flat sides of the hexagonal one, parallel to the paper. In this way the form intended is seen at a glance, and is unmistakable.

Many draughtsmen will persist in turning the corner to the observer; when that is done it is not always possible to tell, without reference to another view whether the nut is square or hexagonal. This may lead to mistakes, and, at any rate, it causes more trouble to him who reads the drawing than it saves to him who makes it. This can very easily be avoided by showing the nut in the position recommended, and as we shall have occasion to show hereafter, it is very rarely that any real necessity exists for doing otherwise.

The center lines, it will be remarked, are drawn in. This ought always to be done, in a working drawing, whether it be of the full size or on a reduced scale, and as was insisted on at an early stage, they should deserve their name; they imply symmetry, and few things mar the appearance of a drawing, especially one on a small scale, more than to have center lines misplaced. Nor will it do to plead that the figures are all right; to be sure the results are not so bad as those of errors in dimensions; but still, inaccuracies in such matters are good grounds for inferring carelessness on the part of the draughtsman; for the lines do not draw themselves, and if they are not in the right place somebody must have put them in the wrong place.

By attention to the preceding the faults in the drawing of the bolt and nut, to which allusion was made, will be avoided; still, in order to impress upon the reader the fact that they are faults, we give illustrations of them. In Fig. 14 is shown a very common one, in which attention, no doubt, is to indicate the screw-thread as we have done in Fig. 8; but the roots instead of the crests of the threads are made shaddow-lines. We have heard it gravely argued that this is right, because they are in shaddow. Very true; but how did they come to be there?

A still more crude attempt is sometimes made by drawing simply a series of parallels clear across the bolt, making those at the roots as long as those at the crests, as in Fig. 15.

AMERICAN FILES.

THERE was hardly any department of the Exhibition in which a visitor could observe so well and would be impressed so much with what the scientific men call the process of evolution which is constantly going on in different branches of manufacturing. A file seems about as simple a tool or instrument as can well be imagined, and yet it is surprising how much can be learned about them from an expert in their manufacture, as we discovered after an interview with the representatives of the two companies whose exhibits are described.

The American File Company, of Pawtucket, R. I., exhibited its goods in a cluster of cases in which it displayed in all 1,482 files, which are also all made by machinery. In perfecting the machinery and processes of manufacture of files, it has made a system of the most elaborate experiments, which occupied about two and a half years. Leaving out of consideration the material of which a file is made, its cutting qualities are dependent upon the shape of the teeth and their angle, or "slash," as it is called—that is, the inclination or angle of the rows of teeth to the longitudinal center line of the file. In cutting a file by machinery, it is laid on an inclined bed whose position can be altered at will. The cutting tool falls vertically on the file, so that the position of the bed determines the angle of the teeth. By a series of experiments, that is, by cutting a large number of files with teeth of different forms, the best shape was arrived at, and in the same way a large number 1¼ inches wide, were cut with the "slash" varying one degree from a right angle until the length of the slash was 2 inches in the width of the file. It can readily be seen what a vast number of combinations are possible with these two varying elements. This was further complicated by the fact that files must be used to cut different materials, such as iron, steel and brass, so that the best *average* result with these three materials had to be determined.

In making such a series of experiments, it was of course necessary to arrive at results as nearly absolutely correct as possible. In order to do this a testing machine was constructed, of which we give in Fig. 1 a rough sketch of the principal parts. It consisted of a horizontal reciprocating bar, *CD*, which is worked by a crank, *B*, in the slot *A*.

To the ends of this bar the files, *FF*, to be tested are attached, and bear upon vertical bars, *Fa, Fa*, of steel or other material. It should also be stated that the machine is so constructed that the files bear on these bars only during their forward strokes. The contrivances by which this is effected are, however, not shown in our sketch. The vertical bars, *Fa, Fa*, which are the objects to be filed, are pushed upward against the files by means of a weight, *W*, which is suspended to a thin steel band or ribbon, *a b c d c b a*, which passes over the pulleys *b, b, c, c*, and *d*. It will readily be seen that each of the vertical bars will be pressed upward by the weight,

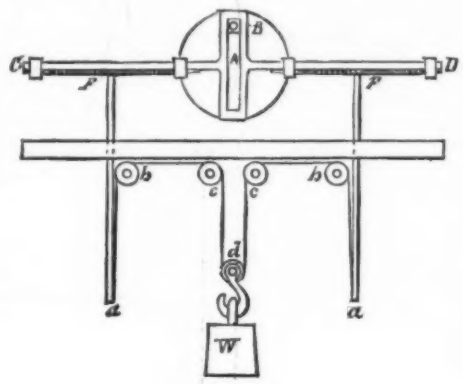


Fig. 1.

W, against the files with a force which will be exactly the same for each. By measuring the length of the bars before the machine is started and then after any length of time, the quantity filed away by each file will give some idea of the relative efficiency of the files, and it can thus be easily determined which one wears out soonest or does the least work.

This machine is also used for testing the quality of steel. It will thus be seen that this company has arrived at the processes and methods of manufacture by strictly scientific methods.

The steel used for files is of a lower grade, that is, has less carbon in it than tool steel, and the files are hardened by heating them in melted lead and then plunging in salt water. This is a very difficult process, as the files must be straightened at the same time that they are tempered, and to do this they must be kept hot enough to bend and at the same time the surface must be kept so cool that the heat will not draw the temper, which is the reason why a lower grade of steel must be used for this purpose. The machinery employed in the manufacture of files is the Bernot patent.—*Railroad Gazette.*

STEAM WATER EJECTOR.—Friedmann's ejector is being tried at Portsmouth dockyard for emptying leaky ships. It acts on exactly the same principle as the injector. A perforated pipe, or suction filter, is laid on the keelson of the vessel, and is connected by means of a pipe to the boiler; and the pipe has an outlet above the deep load line. When steam is turned on the water which has accumulated in the filter pipe is expelled. The question to be settled is the quantity of steam required. The largest ejector yet made will discharge 300 tons of water per hour, and it is thought that the larger ones may be used to prevent vessels sinking even when they have leaks admitting 1,000 tons of water an hour.

NEW SOURCE OF ARSENIC POISONING.—In the case of a lady in Paris who complained of symptoms, which led the physicians to regard it as a chronic case of poisoning, it was finally ascertained that the brilliant white candles used in her bedroom, had been strongly impregnated with arsenic during the bleaching process, and that the poisonous constituent was volatilized during the burning of the candles at night.

PACKING OF DYED WOOLS.

It is, according to *Reimann's Farber Zeitung*, a fact of frequent recurrence that dyers working in wools suited for tapestry purposes receive their goods returned after they have been packed in white paper, for reason of these wools showing light spots. Careful observations have shown that this defect is most generally observed with aniline dyes—especially with magenta—and that these light spots merely present themselves where these yarns have been in direct contact with the white paper, and this fact has led to the solution of this remarkable effect. It is well known that the materials used in the manufacture of white paper, such as rags, straw, esparto, etc., are subjected to a strong bleaching process by the use of chlorine; if the latter is not removed in the manufacture of this white paper by some anti-chlorine solution, then some traces of the chlorine will always remain (in very small quantities, it is true) in the white paper. When it is remembered that aniline dyes are extremely sensitive to the action of chlorine, it may be easily understood that the coloring matter fixed on these wools will fade at all such places where it comes in direct contact with the white paper, that is, with the traces of the cholorine left.

As a preventive caution, it would be well for dyers, when working in such wools, not to pack the latter in white, but in blue papers, or, if the latter shade cannot be obtained, choose a dark-tinted paper. Blue-colored paper wrappers are to be preferred, on account of the ultramarine used in dyeing, it being very sensitive to the action of chlorine; therefore any presence of chlorine in the paper itself becomes thus already neutralized by the subsequent dyeing process of the paper, so that the chlorine has then no chance of eventually working on the dyes of the wools suited to tapestry purposes

LOGWOOD.

A RECENT LECTURE BEFORE THE SOCIETY OF ARTS, BY GEORGE JARMAIN.

Perhaps, with the exception of madder, there is no one dye ware which has such extensive application as logwood, and in wool-dyeing, in which madder finds more limited use, no other ware can be compared to logwood in utility. The use of proper mordants, and a better knowledge of the properties of the coloring matter of logwood, have enabled dyers to obtain such fast and permanent colors with it, that the ban under which it formerly lay, arising from the fugitive nature of the colors obtained by the dyers who first used it, has long since passed away.

The natural history of logwood and other woods and wares which I shall have occasion to deal with, together with the properties of their coloring principles, have been so well described by my predecessors on this platform, especially by the late lamented Dr. Crace Calvert, that I do not deem it necessary to enter into that full detail which I should otherwise have done, and I therefore intend to dwell more at length on the special properties of the coloring matters, which much concern the practical dyer, and also on those various details of the dyehouse which are so essential to the successful prosecution of the dyer's art.

Logwood is imported into this country from Central America and some of the West Indian Islands in blocks or billets.

That brought from Campeachy is esteemed the best, but is now scarce, and the price is high. The next best is Honduras, of which there is a large consumption in the woollen trade. Jamaica and St. Domingo are common qualities which are also in considerable use.

Logwood is the wood of a large tree belonging to the Leguminosæ family, and is called *Hematoxylon campechianum*.

It is prepared for the use of the dyer in the three following forms: 1st, in chips; 2d, ground or in raspings; 3d, as an extract which is the solid or semifluid residue obtained by evaporating the decoction of the wood.

The coloring matter is developed by moistening the chips and raspings with water, and allowing the mass to ferment slightly in a heap, taking care that the fermentation does not proceed too far.

The water used for moistening the logwood should be free from iron or peaty matter, both of which damage the appearance and quality of the wood.

The chips of good logwood gradually become coated over with a green color, somewhat like that reflected from a beetle's wing.

When the chips are used for dyeing, which is the most common form in which logwood is employed for wool and heavy pieces, they are placed in a bag, made of coarse open material, and hung down into the boiling water, which is intended as a dye-bath, until the coloring matter is extracted; the bags are then removed, and the material to be dyed put in.

Rasped logwood is thrown into the dye-bath along with the material to be dyed.

The coloring matter of logwood assumes two conditions:
1. A colorless condition, called hæmatoxylin ($C_{16}H_{14}O_6$).
2. A colored principle called hæmatëin ($C_{16}H_{12}O_6$).

The difference, it will be observed, between the two is similar to that which obtains between indigo white and indigo blue, namely, a difference of two atoms of hydrogen.

The oxidation of the colorless hæmatoxylin results in the formation of the colored hæmatëin from exposure to air. These facts were discovered by M. Chevreul.

The coloring matter does not exist in either condition in the wood itself, but is the result of the fermentation of a glucoside.

The hæmatëin is susceptible of further changes under the influence of ammonia.

The coloring principle, hæmatëin, is the body which the dyer uses as a tinctorial agent; it is that which gives the red color to the prepared dyewood, and the green substance, with green cantharides reflection, which is seen on the chips, is the hæmatëin which has effloresced from the damp logwood and dried on the surface.

LOGWOOD COLORS.

A variety of shades of color can be obtained with logwood alone as the coloring agent, and it enters into the composition of a still greater variety of composite colors. It is essentially a blue coloring matter, and is hence frequently called by the French *bois bleu*. The shade of color which it imparts to wool is very much modified by the various mordants. Logwood colors are affected by acids which turn them red, and alkalies which change them to blue or purple. By varying the quantity of logwood, various shades of blue are obtained from lavender, with two per cent. of logwood, to a dark blue with 30 per cent., which shade becomes very dense and full when the percentage of logwood is increased to 60 or 70 per cent. The darker of these colors are constantly produced in the dyehouse, both on wool and cloth.

RECEIPTS.

Though dyers' receipts are often instructive in indicating the directions which the dyer may take in order to obtain any given color or shade of color, the conditions under which he may work are subject to such a great amount of variation that I deem it necessary, at the outset, to give a word of caution, and to impress upon him the fact that the literal interpretation and carrying out of almost any receipt will produce results alike in the hands of no two dyers, who may happen to be differently circumstanced.

This is readily accounted for when we consider that the wares may be different in the percentage of coloring matter and tone of color, the mordants of varying strength, the water often altogether different in quality, the varying dimensions and kind of dyeing vessel used, the different effects of steam and fire heat, and the variations produced by operating on a larger or smaller weight of material. In fact, the varying conditions are so numerous, that dyeing receipts are often illusory on account of the differences which have been enumerated above. The receipts which I shall therefore have occasion to give from time to time, I wish to be accepted with caution, and interpreted with some latitude as to quantities of dye wares, etc.

The receipts are given as typical examples of processes in actual use in the woollen districts in dyeing goods on the large scale, and are not put forward as the very best modes; these can only be found out according to the different circumstances under which the dyer is placed, and they are often only the result of careful observation and long practice.

The term fast is used in the receipts for a color which will fairly withstand scouring and milling, but not necessarily the action of light and atmospheric influences. By permanent is meant a color that will withstand all deteriorating influences both in milling and scouring, and also those to which it may be subjected during a reasonable time of wear. The terms loose and fugitive are applied as opposites to fast and permanent. These definitions are given, not as representing what is frequently attached to them by authors on dyeing, but as those which I wish to be attached to them in these receipts, and which I think may be conveniently applied. The receipts are all given for 100 lbs. of wool or cloth, except when otherwise stated.

COMMON BLACK AT ONE OPERATION.

	Per cent.*
Logwood	40
Sulphuric acid	0·5

Boil half an hour.

Copperas	3
Blue vitriol	1

Throw on solid or in solution, and boil half an hour longer. Let off and leave over night.

Color, loose, turning brown in the wear, used for dyeing colored waste intended for low class goods. Sumac might be used with advantage for a black of this description.

This is a loose color because a good deal of the coloring matter is converted into a lake, and is, therefore, only loosely attached to the fibre. "The old dyers generally dyed in one bath only, which in part explains the bad results obtained."†

COMMON DOESKIN BLACK.

Mordant—

	Per cent.
Copperas	3½
Blue vitriol	2
Alum	2
Red argol	3
Logwood	3½

Boil for five minutes, cool down to 100° F. with water, enter the goods, raise to the boil in three-quarters of an hour, and boil for an hour and a half. Lift out and leave over night. Some dyers wash off, others leave unwashed.

Dye—

	Per cent.
Logwood	24
Red argol	1

Boil for five minutes, cool down to 180° F. with water, enter the goods, raise to the boil in half an hour, turning by the wince—quickly at first—and boil for another half hour, wind out, cool down over the perch, and wash on the machine with fuller's earth.

If the goods have been manufactured partially from mungos, which often contain cotton threads, commonly called burls, it will be necessary to burldye them, an operation in which the particles of cotton are dyed black. This operation consists in steeping the cloth in a cistern containing an infusion of tannin material, commonly sumac or myrabolams, afterwards passing them through a solution of pyrolignite or so called nitrate of iron (nitro-sulphate of iron). The pieces are then finally washed on the machine with fuller's earth. Color fast, but not very permanent, becoming brown in the wear.

DOESKIN BLACK FOR WOOL.

	Per cent.
Camwood	8

Boil for 50 minutes. Then add

Bichrome	3
Alum	1
Argol	1

Boil for 50 minutes, let off, and allow to stand over night.

Dye in

	Per cent.
Logwood	45
Fustic	8
Sumac	4

Boil for one hour and a half; let off. Color fast and permanent.

This formula contains all the colors necessary to produce a black, namely, red, blue and yellow. Camwood furnishes the red, logwood the blue, and fustic the yellow. Chromed logwood colors have a tendency to become green, from the production of chromic oxide; the presence of camwood or other red color makes this change less apparent.

CHROME BLACK WITH BLUE REFLECTION (BLUE THROUGH) FOR WOOL.

Mordant—

	Per cent.
Bichromate of potash	2
Sulphuric acid, D.O.V	0·25

Boil one hour and a half, and leave over night.

Dye—

Logwood	45 to 55

Boil one hour.

If required very clean, as in mixtures of black and white (black and white checks for example), the color may be fixed more firmly by finally passing it through a warm bath containing 5 per cent. bichromate of potash.

CHROME BLACK WITH VIOLET REFLECTION (VIOLET THROUGH) FOR WOOL.

This is mordanted and dyed as the last. The violet reflection is obtained by using the following modifier—Single muriate of tin, 1 to 2 pints. Mix the tin spirit in 20 or 30 gallons of water and throw it on the wool, handling up for 15 minutes.

CHROME BLACK WITH GREEN REFLECTION FOR WOOL.

Mordant—

	Per cent.
Bichromate of potash	2
Sulphuric acid	·25

Boil one hour and a half, and leave over night.

Dye—

Logwood	40
Fustic	10

Boil one hour.

Color fast and moderately permanent, becoming greener and paler.

WOODED BLACKS.

These are the best blacks for either cloth or wool; they are obtained by first dyeing the goods in the indigo vat a light or medium shade, and then dyeing them as for chrome blacks, using less logwood in proportion, as the indigo bottom is more or less dark. Color fast and permanent.

LAVENDER ON WOOL.

	Per cent.
Alum	1½
Tartar	·25
Logwood	2½
Indigo extract	·25

Boil for five minutes, cool to 180° F. with water; enter the goods and boil for one hour. Let off and wash. Color moderately fast.

CUDBEAR, ARCHIL PASTE, AND ARCHIL.

These coloring matters, though not obtained from wood, may with advantage be described here, as they are often employed with logwood and the other woods in many composite colors; these three coloring matters are all obtained from the same sources, namely, certain lichens or weeds, the two principal species of which are *Rocella tinctoria* and *Rocella fuciformis*.

The weeds contain no coloring matter, this being produced by exposing them to the action of ammonia. Drs. Stenhouse, Schunk, and others, have investigated the coloring matter contained in these dye wares, and have found several distinct coloring principles in them.

Cudbear is made by drying archil paste, and then grinding the residue to a fine powder; the coloring matters of cudbear are more red than those of archil, but even these may be varied by differences in the manufacture, both red and blue archils being produced for the market.

These colors are employed largely as a bottom or ground for indigo on wool and cloth, and also, as before stated, for many mixed or composite colors, but the colors are somewhat fugitive.

The mordants affect the shade of color only to a small extent, in fact they may be employed without mordant. They are most affected by a mordant of tin, chiefly through the influence of the free acid contained in the tin spirit, which, like all other acids, reddens and brightens the color, changing it to a maroon. The weed colors, as they are called, are mostly used for the purpose of modifying and blooming other colors, but as they are fugitive, the bloom soon passes away. Their brightness and beauty, however, render them exceedingly well adapted for the colors required for ladies' wear.

The following formula is given as an illustration of the use of cudbear along with logwood:

LOGWOOD BLUE FOR WOOL.

Mordant—

	Per cent.
Bichromate of potash	1
Alum	3
Tartar	1½

Boil for one hour and a half, let off, and leave over night.

Dye—

	Per cent.
Logwood	20
Cudbear	1

Boil for one hour, then throw on 20 quarts single muriate of tin, diluted with 20 or 30 gallons of water. Handle up for fifteen minutes; let off and wash. Color moderately fast.

THE RED WOODS.

These important dye wares comprise two classes: 1. Red woods, whose coloring matters are freely soluble in boiling water; these include Brazil-wood, Lima-wood, Santa Martha or peach-wood, Sapan-wood, and Pernambuco-wood. 2. Red woods which are almost insoluble even in boiling water; these include camwood, barwood, and sanderswood, and caliatour.

The first class is imported in the form of blocks or billets from Central and South America, and the West Indies, and is sold to the woollen dyer in the powdered state. They are said to contain the same coloring principle, called by Chevreul, who first obtained it, by the name of brazilin; it can be obtained in needle-shaped crystals, which are nearly colorless, and have a bitter-sweet taste. By oxidation it is transformed into brazilëin, by a change which is analogous to that which takes place when indigo white becomes indigo blue, and when hæmatoxylin becomes hæmatëin. The change may be expressed by the following equation:

$$\underset{\text{Brazilin.}}{C_{22}H_{14}O_7} + O = \underset{\text{Brazilëin.}}{C_{22}H_{12}O^7} + {}_2H_2O$$

I find that peachwood is almost the only wood of this class which is employed in wool dyeing, and that only to a limited extent; it is never used as a self color, its chief employment being for the purpose of imparting a purple tone to other coloring matters.

The second class, embracing camwood, barwood, sanderswood, and calinatour, is very important to the wollen dyer. They are the produce of several species of Pterocarpus, which grow in tropical countries, and are imported into this country in the form of knotty billets or blocks, which are prepared by rasping for the use of the dyer; the wood, on account of the very slight solubility of its coloring matter, is generally boiled in contact with the article to be dyed. The colors which they impart to wool are red, or red brown, with a mordant of tin, alum, or bichrome, the color being of a dull shade when copperas is used; the colors are very permament and fast, and are on that account much employed in the dyeing of wool and woollen cloths, which have to be scoured and milled.

The coloring matter seems to be the same in all; there is a colorless principle called santal, which by oxidation is transformed into the red coloring matter, santalin, by a reaction analogous to those which take place in the coloring matters of indigo, logwood, and peachwood.

These woods are seldom or never used alone as a coloring matter for wool, their principal employment being to give the requisite red tone to browns, clarets, violets, maroons, blacks, and other colors which contain a red in their composition; they are also the best bottoms for indigo which can be put on, being much faster and more permanent than a bottom obtained with archil or cudbear.

CLARET BROWN ON WOOL.

Mordant—

	Per cent.
Bichromate of potash	1½
Sulphuric acid	25

Boil for one hour; leave over night.

Dye—

Camwood	34
Barwood	10
Logwood	2
Cudbear	1

Boil for two hours; let off.

The shade may be considerably darkened by the addition of copperas towards the end of the operation.

MADDER.

This coloring matter is more extensively used by the cotton dyer and calico printer than it is by the woollen dyer. It has been the subject of much research, and the composition and nature of its coloring principles are now well understood. It has long been used as a dye stuff; the ancient Egyptians, the Greeks, and the Romans are said to have used it.

* The percentages given in this and the following receipts are for 100 of wool or woollen fabric.

† Van Laer.

Though not a wood it will be best to discuss it here in connection with the red woods, as it holds, as a woollen dye, a position intermediate between that of the red woods and the yellow woods. It is the root of a plant called *Rubia tinctorum*.

Dr. Schunk states that the coloring matter exists in the plant as a glucoside, that is, in combination with a sugar. He calls the glucoside rubian.

The principal coloring matters yielded by madder are alizarin, purpurin, and pseudo-purpurin, of which the first is by far the most important, being the only madder color which may be considered fast and permanent.

The artificial production of alizarin from anthracene, one of the products of the distillation of coal tar, is one of the most important and interesting applications of chemistry to the arts that has been made of late years.

In 1868 Græbe and Liebermann found that when alizarin and zinc dust were distilled, the hydro-carbon anthracene was obtained, and by reversing the process they succeeded in obtaining alizarin from anthracene. The artificial coloring matter seems to possess all the properties of the alizarin of madder.

I am not aware that artificial alizarin has yet been used in the woollen districts as a dye for wool.

In wool dyeing the chief uses of madder, besides acting as a ferment in the indigo vat, are for the production of drabs, browns and olives, for which its coloring matters are well adapted. The colors obtained with madder on wool are very fast and permanent.

BROWN ON WOOL.

Mordant—

	Per cent.
Bichromate of potash	1
Sulphuric acid (D.O.V.)	5

Boil one hour; let off, and leave over night.

Dye—

Madder	11
Logwood	1
Camwood	8
Fustic	10

Boil for two hours; color fast and permanent.

MODE OF TESTING THE VALUE OF DYEWOODS.

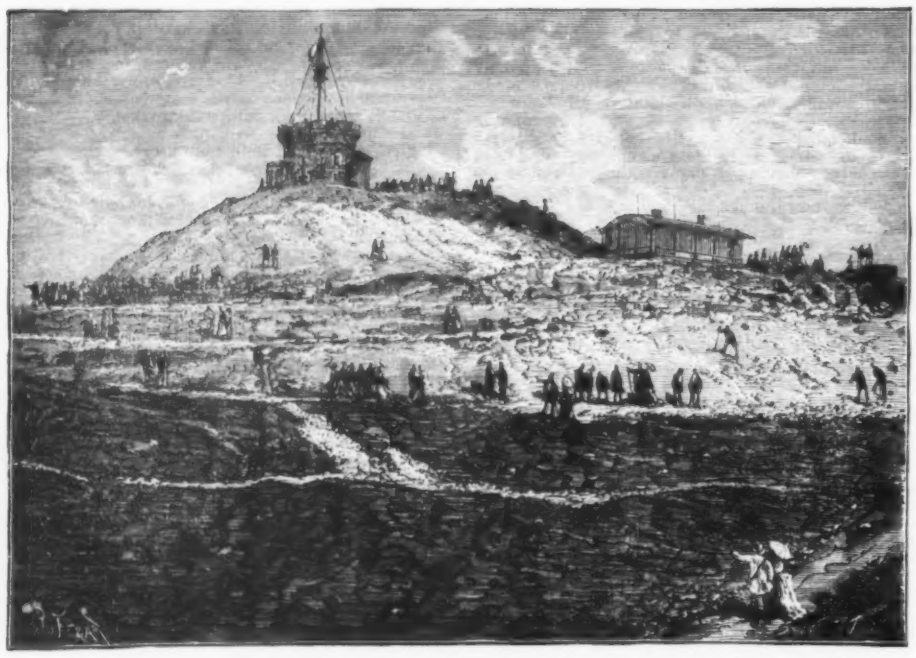
The best practical test that the dyer can employ is to dye swatches of cloth of equal weight with equal weights of the dye to be tested, and of a known good sample, and comparing the results in each case. The master dyer will find it to his advantage to test his dyes himself, by which means he will be able to know when he is having full value for his money.

THE NEW SCIENTIFIC OBSERVATORY ON THE SUMMIT OF PUY-DE-DOME, FRANCE.

A new observatory, destined for meteorological and other scientific purposes, has recently been established on the mountain peak known as Puy-de-Dôme in the south of France. The elevation is 4,688 feet above the sea level. Two substantial structures have been erected. One is the residence of the observer permanently located at the station, and herein is a telegraph office whence weather despatches will be transmitted to all parts of the country, and laboratories for scientific men who may desire to sojourn on the mountain in order to conduct special investigations. From this building a subterranean passage leads up to the structure on the summit of the peak, shown at the left of the engraving. The tunnel ends in a dark cellar which has been carefully prepared with cemented walls and floor provided with perfect ventilation, &c., so as to adapt it as a place for the study of delicate magnetic phenomena. The floor above is likewise under ground, but is lighted by skylights, and is surrounded with double walls so that it has what may be termed an isolating air space around it. In the interior of this apartment are to be kept such instruments as require a regular and constant temperature for their proper working.

The top story is designed for observation of clouds, &c. and is provided with wet and dry thermometers, two electric anemographs, one elevated at the summit of a tall pole, a plunometer, a thermo hygrograph, barometer, telescope, regulating clock, etc. All of this apparatus is of novel design, and of the most delicate and accurate construction.

Puy-de-Dôme is famous as the scene of the experiment which resulted in the demonstration of the theory of the barometer. Torricelli long before had said that the weight of the air is sufficient to keep a column of mercury at a height of 30 inches in vacuum, but his assertion was ridiculed. The celebrated French writer, Pascal, suggested testing the question by transporting the mercury to the peak of Puy-de-Dôme. One Perrier acted on the hint, and he saw the mercury fall nearly three inches at the summit of the mountain, to rise again to its former level as he descended into the valley. The French give all the credit of the proof to Pascal, and the speeches of the members of the French Association for the advancement of sciences (which *La Nature*, whence we derive the annexed engraving, quotes) on the occasion of the inauguration of the new observatory, contain no mention of Perrier.

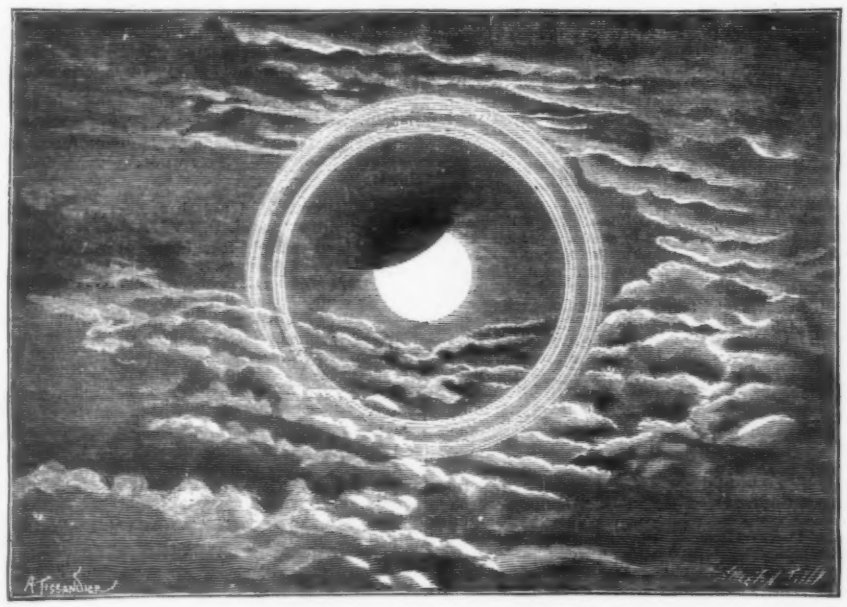


THE NEW SCIENTIFIC OBSERVATORY ON THE SUMMIT OF PUY-DE-DOME, FRANCE.

PHENOMENA OF LUNAR ECLIPSES.

The annexed illustration represents the partial eclipse of the moon visible in France on September 3d last, at the moment when our satellite was most obscured by the earth's shadow, which covered about one-third of the lunar diameter. The interest of the phenomenon was increased by the appearance of a magnificent halo, and by the presence of light cirrhus clouds which added to the grandeur of the scene.

It is a notable fact that total or partial eclipses of the moon always lasts longer than the calculations predict. The reason is that astronomers calculate the diameter of the shadow cone which has the earth as its base, at the point where the moon traverses it, without taking into consideration the absorption which the solar rays experience in passing through the strata of varying density in the earth's atmosphere. This absorption may be great enough to intercept the light of the sun almost completely and to produce the same effect as would an augmentation of the terrestrial diameter. Hence there is an increase in the diameter of the shadow cone which is projected into space. Cassini estimated this increase at 40 seconds, Monnier at one minute; but it is clear that this should depend on the position which the line of separation between light and shadow occupies on the earth's surface, as such line becomes unequal at various points according as the air is more or less dense, or more or less charged with clouds and vapor. It has been suggested that for this circumstance the state of the atmosphere is various terrestrial regions may be determined. Thus at the end of the eclipse of June 1, 1863, the occidental half of the lunar crossing which formed the portion of the disk free from shadow remained obscure, while the oriental half was illuminated. The solar rays, it was explained, which met the moon on the oriental side of her disk touched the earth probably on the open sea, while the rays meeting the occidental portion were probably obstructed by Greenland glaciers, the elevation of which, some 1,500 feet above sea level, sufficed to produce a difference of 4 minutes in the inflexion of the luminous rays. A bank of elevated clouds in this way would produce an effect similar to that due to an elevated continent.



PHENOMENA OF LUNAR ECLIPSES.

FRENCH ACADEMY OF SCIENCES.

NOVEMBER.

On the Physical and Chemical Properties of Ruthenium. By MM. Deville and Debray.—Ruthenium heated in oxygen does not become transformed as does osmium into an acid product volatile at 212° Fah. It gives an oxide $Ru\ O_2$ which sublimes at a bright red heat. On attacking ruthenium deprived of osmium with a mixture of nitre and potash, it is transformed into a soluble orange ruthenate. The authors are studying in succession, crystallized ruthenium, of which the density at 32° Fah. is 12.261; a new acid of ruthenium, hyperruthenic acid, $Ru\ O_4$, which does not seem to combine with bases; ruthenious acid, $Ru\ O_2$, which, with potash, gives orange solutions and heptaruthenic acid, $Ru_2\ O_7$, which yields with potash a black salt the solution of which is dark green. Hyperruthenic acid, $Ru\ O_4$ of Claus, of which the characteristic property is its volatility, possesses even below 212° a considerable tension of vapor, and decomposes with explosion at 226° F.

New Researches on Chemical Phenomena produced by Tension Electricity. By M. Berthelot.—The author has examined what relations may exist between these reactions and the sign or the tension of electricity. Ozone is formed equally under the influence of both kinds of electricity, though in the majority of cases positive electricity produces the greater quantity of the gas. Only under the influence of strong discharges, however, is ozone formed in abundance. The author states that he has been unable to note the least trace of nitrous compounds on subjecting nitrogen or oxygen, dry or moist, to the action of the Holtz machine. With the discharge of the Ruhmkorff apparatus, traces have been observed; but only under very high tensions. Acetylene, on the contrary, manifests itself in notable quantity in the vapors of organic compounds enclosed with nitrogen, in tubes which contain a metallic armature influenced by discharges from the Holtz machine. The absorption of nitrogen by organic compound takes place equally under the influence of both kinds of electricity, and as well with the weakest as with the strongest tensions, though in a longer time.

On the Compositions of some Phosphites. By M. Ad. Mertz.—The author has demonstrated that crystallized phosphoric acid contains 3 atoms of hydrogen, and that the phosphites contain for every 2 atoms of a monoralent metal, 1 atom of hydrogen. Starting from this, he is now studying calcium phosphite $PH\ Ca\ O_3$, neutral phosphite of barium $Ph\ Ba\ O_3$, and acid phosphite of barium $P_2\ A_4\ Ba\ O_8$.

On the Modifications of Elæomargaric Acid produced by Light and Heat. By M. Cloez.—The author has shown that the oil extracted by pressure from the seed of *Elæococca vernicia* furnishes by saponification with an alcoholic solution of potash, a perfectly crystallized salt, from which a fatty acid is separated regularly fusible at 118.4° Fah. This is called elæomargaric acid, and is a superior homologue of sorbic linoleic and palmitolic acids. Elæomargaric and elæostearic acids submitted to the action of heat become transformed into a liquid product, elæolic acid. The author considers that the foregoing observations on elæomargaric acid explain fully the curious properties of elæococca oil.

On the Composition of Gun-cotton. By M. Abel.—The author shows that instead of there being but one kind of gun-cotton, as commonly supposed, there is two. One contains 3 equivalents of nitric acid, merits the name of trinitro cellulose, is excessively explosive, but does not dissolve in ethereal reagents. The other, which contains but two equivalents of acid, is the basis of collodium. This distinction will serve to elucidate many of the difficulties encountered in the study of the substance.

On a New Process of Determining the Presence of Fuchsine in Wine. By M. Fordos.—The author agitates 61 cubic inches of wine for several seconds with 10 drops of pure ammonia, in a test tube. From 30 to 60 cubic inches of chloroform are added, the agitation is continued, and finally the whole is poured out upon a glass dish. When the chloroform has collected on the bottom it is drawn off by a suitable cock, and gathered in a porcelain capsule, which is placed in the sand bath. A small piece of white silk is then placed in the chloroform, which is heated. As the chloroform volatilizes, the fuchsine, if any be present, turns the silk rose color. Towards the end of the operation water is added to fix the dye, and the shade of the silk determines the quantity of fuchsine contained in the wine. Of course, if the wine be pure, the silk remains colorless.